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SUMMARY OF PARTICULATE AND SULFUR OXIDE EMISSION REDUCTIONS ACHIEVED NATIONWIDE FOR SELECTED INDUSTRIAL SOURCE CATEGORIES 1970 - 1975

VOLUME 2. CALCULATIONS

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VOLUME 2: CALCULATIONS

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement
Division of Stationary Source Enforcement
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This research updates the nationwide emission data on total suspended particulates and sulfur oxides from selected source categories for 1975, and the associated analyses to determine the progress made, nationwide, in meeting the ambient air quality standards for the two pollutants under study. The initial inventories and analyses were developed by the Research Triangle Institute under Task Order No. 21, Contract No. 68-02-1325 and reported to EPA in June 1975.* The analyses and inventories developed in the June 1975 studies are updated to reflect changes in SIP requirements proposed or promulgated since the initial study, use of actual 1975 production data in place of projections, and use of compliance status data available in the DSSE Compliance Data System.

This report is published in two volumes. Volume 1 presents a summary of the emission inventory data and the analyses; Volume II, the detailed calculations, in appendix form, upon which nationwide emission inventories-actual, potential, and compliance-were based.

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Volume II

by

Martin F. Massoglia

Prepared for:

Division of Stationary Source Enforcement
Environmental Protection Agency

under

Task Order No. 66, Contract No. 68-02-1325

and

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August 1976
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FOREWORD

This research was performed for the Division of Stationary Source Enforcement (DSSE), Environmental Protection Agency under Purchase Order No. DA-6-99-5332J and Task Order No. 66, Contract No. 68-02-1325 with the Environmental Protection Agency/Durham. Mr. Robert Marshall, Compliance Monitoring Branch, Division of Stationary Source Enforcement was the EPA Project Officer. His suggestions and comments during the conduct of this research were most helpful.

This research updates the nationwide emission data on total suspended particulates and sulfur oxides from selected source categories for 1975, and the associated analyses to determine the progress made, nationwide, in meeting the ambient air quality standards for the two pollutants under study. The initial inventories and analyses were developed by the Research Triangle Institute under Task Order No. 21, Contract No. 68-02-1325 and reported to EPA in June 1975.* The analyses and inventories developed in the June 1975 studies are updated to reflect changes in SIP requirements proposed or promulgated since the initial study, use of actual 1975 production data in place of projections, and use of compliance status data available in the DSSE Compliance Data System.

This report is published in two volumes. Volume I presents a summary of the emission inventory data and the analyses; Volume II, the detailed calculations, in appendix form, upon which nationwide emission inventories—actual, potential, and compliance—were based.

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*Massoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volumes I and II, Research Triangle Institute, June 1975.

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SUMMARY

The calculations for the fourteen selected source categories are summarized in table 1.

Table 1

ESTIMATED POTENTIAL AND ACTUAL EMISSIONS (1970, 1975)
10^3 tons

1970 Source Categories	Particulates					Sulfur Oxides				
	1970		1975			1970		1975		
	Potential[1]	Actual	Potential	Actual	Compliance[2]	Potential[1]	Actual	Potential	Actual	Compliance[2]
Coal-Fired Steam Electric Power Plants	34,533	4,188	49,352	3,760	756	15,439	15,439	20,971	13,536	11,481
Oil-Fired Steam-Electric Power Plants	54	54	80	80	80	1,618	1,618	2,022	1,692	1,555
Coal-Fired Industrial/ Commercial Boilers	4,501	2,545	3,959	1,287	401	5,529	5,529	5,131	3,530	2,788
Integrated Iron and Steel Mills and Coke Plants	15,259	2,346	12,760	1,469	386	197	180	173	110	25
Petroleum Refineries[3]	283	130	324	148	146	1,537	1,537	1,759	1,498	1,312
Primary Smelters	1,637	190	1,553	145	100	4,845	3,580	4,629	2,965	603
Portland Cement Plants	10,543	906	9,604	305	66	733	733	661	661	661
Municipal Refuse Incinerators	184	105	203	73	16	–	–	–	–	–
Sulfuric Acid Plants	–	–	–	–	–	581	581	626	350	183
Phosphate Fertilizer Plants	172	24	167	14	12	–	–	–	–	–
Ferroalty Plants	366	71	313	34	29	–	–	–	–	–
Asphalt Concrete Plants	6,998	526	7,088	203	120	–	–	–	–	–
Coal-Cleaning Plants	671	217	372	35	11	–	–	–	–	–
Kraft and Sulfite Pulp Plants	3,133	288	3,789	146	38	–	–	–	–	–
Grey Iron Foundries	1,320	156	899	62	46	–	–	–	–	–
Subtotal Selected Source Categories	79,754	11,752	90,463	7,761	2,207	30,479	29,197	35,972	24,342	18,608
All Sources	98,479[9]	27,500[5]	110,339[9]	17,000[4]	9,798[9]	39,586[4]	34,300[5]	45,639[9]	32,900[4]	26,568[9]
Other Sources	18,725[4]	15,748[7]	19,876[4]	9,239[7]	7,591[10]	9,107[7]	5,381[7]	8,667[4]	8,558[7]	7,960[11]

Note: Footnotes appear on the following page.

[1] Massoglia, Martin, F., Summary of Emissions Reductions Achieved Nationwide by Selected Industrial Source Categories, Volume 1. Final Report. Research Triangle Institute (Tech No. 2), EPA Contract 68 02 135), except petroleum refinery SO_2 emissions. This figure is from Appendix D, this report.

[2] Based on 1975 Activity Factors.

[3] For the purposes of this study, petroleum refinery emissions included the following:

a. Uncontrolled -- Emissions from catalytic cracking regenerators, boilers and process heaters, and flaring or burning all of these off gases without prior desulfurization.

b. Contracted -- All off gases, and combustion products processed through a sulfur recovery unit with a 99.5 percent effective sulfur recovery.

c. Actual -- Emission from all operations including sulfur recovery units at level of control estimated to be in effect in 1970 and 1975.

[4] Calculated from data in OAQPS Data File of National Emission, 1970 and 1971.

[5] NADB internal paper. Air Pollutant Emission Estimates 1970-1974, undated.

[6] Preliminary 1975 data provided by NADB.

[7] By difference (all sources minus Selected Source Categories).

[8] Projected from 1970 based on population growth.

[9] By addition (Other Sources plus Selected Source Categories).

[10] Estimated assuming area source emissions are relatively uncontrolled and process emissions included in other sources all at 91 percent control. Process emissions in other sources are assumed to be from industrial processes. Combustion emissions in other sources are assumed to be area emissions. Calculations follow.

1975 emissions from other sources (estimated from data in OAQPS Emission Data File and activity factors provided by C. Mann, NADB) are:

Total	19,876 tons
Area	6,435 tons
Process	13,441 tons

Assuming process emissions included in other sources are from small plants with an average throughput of 15 tons per hour and process emissions in the selected source categories are from larger plants -- average hourly throughput of 75 tons, an estimate of degree of control at compliance with emission limitations can be made using the process rate emission curves.

Large plants $E = 55(75^{0.11}) - 40$
$= 48.4$ pounds per hour

Small plants $E = 4.1(15^{0.67})$
$= 25.2$ pounds per hour

Under compliance with emission limitations average degree of control for industries in the selected source categories (combustion sources excluded) is 97.6 percent.

$1 - (963/29,271) = 0.976$

This represents an uncontrolled emission rate of 1,467 pounds per hour.

$48.4/(1 - 0.967)$

Assuming the same emission rate per unit throughput for small plants potential emissions are estimated to be 293 pounds per hour.

$1,467(15/75)$

Under compliance with emission limitations process emissions included in other sources will be 1,156 tons per year.

$13,441(5.2/293)$

Total other source emissions at compliance are 7,591 tons per year.

$6,435 + 1,156$

[11] Estimated assuming area sources are relatively uncontrolled and process emissions included in other sources are at the same degree of control as emissions from selected source categories less combustion sources. Analysis of state emission regulations indicate that SO_x emission limitations for industrial sources are not dependent on plant size.

Data in OAQPS Emission Data File indicate that approximately 25 percent of emissions in other sources are from industrial processes and remainder from area sources. Potential 1975 emissions from other sources can be distributed as follows:

Total	9,504 tons
Area	7,128 tons
Process	2,376 tons

At compliance, emissions from selected source categories, less combustion sources would be at 65 percent control.

$1 - 2,784/7,848$

At compliance with emission limitations other source emissions would be:

Area	7,128
Process	832 (2,376 X (1 - 0.65)
Total	7,960 10^3 tons

APPENDIX A

COAL-FIRED STEAM-ELECTRIC PLANTS

OIL-FIRED STEAM-ELECTRIC PLANTS

(Particulates and SO_2)

1970

Baseline year data (1970) are as calculated in initial study. Estimated actual emissions for 1970 are (Ref.1, p.A-15).

	10^3 Tons	
	Coal	Oil
Particulates	4,188	54
SO_2	15,439	1,618

1975

Estimated Actual Emission Factors

Oil and Coal-Fired Steam-Electric capacity in 1975 was under three degrees of control. Plants coming onstream were subject to NSPS and can be assumed to be in compliance therewith. Some of the 1972 plants in place were in compliance with SIP emission limitations. The remainder were emitting at the average 1970 rate. The following emission factors are applicable.

		$lb/10^6$ Btu	
Coal		PM	SO_2
1970-level	[Ref.1, pp.A-11, A-12]	1.18	4.35
NSPS	[Ref.3, pp.24878/9]	0.10	1.2
SIP-level	[See table A-1 for calculations]	0.16	2.48

		$lb/10^6$ Btu	
Oil		PM	SO_2
1970	[Ref.1, p.A-12]	1.18	1.61
NSPS	[Ref.2, pp.24878/9]	0.10	0.8
SIP CONTROL	[See table A-2 for calculations]	0.14	1.06

Uncontrolled particulate emissions from oil combustion are less than the estimated actual emissions under SIP control. Therefore, controlled particulate emissions will be assumed to be the same as uncontrolled or 0.054 $lb/10^6$ Btu [Ref.1, p.A-5].

Table A-1. Allowable Emission Factors, Coal-Fired Steam-Electric Plants Based on Regulations for States Accounting for over 70 percent of Coal Consumption for Electric Generation

State	1972[1] Coal Consumption 10^3 Tons	Allowable Emissions[2] lb/10^6 Btu		Allowable Emissions Weighted by Coal Consumption	
		Particulates	SO_2	Particulates	SO_2
Alabama	16,286	0.12	1.8	1,954	29,314
Georgia	10,937	0.10	6.0	1,094	65,622
Illinois	29,069	0.10	1.8	2,907	52,324
Indiana	26,033	0.30	6.0	7,810	156,198
Kentucky	22,291	0.10	1.2	2,229	26,749
Michigan	20,212	0.22	3.2	4,447	64,678
Missouri	12,527	0.30	2.0	3,758	25,054
North Carolina	18,696	0.22	2.3	4,113	43,001
Ohio	39,768	0.12	1.0	4,772	39,768
Pennsylvania	35,051	0.11	2.1	3,856	73,607
Tennessee	17,155	0.22	2.8	3,774	48,034
West Virginia	19,758	0.05	2.7	998	53,347
Wisconsin	10,120	0.15	1.2	1,518	12,144
Total	277,903			43,220	689,840
US Total	348,694				
%	79.7				

Allowable Emissions

Particulates $\frac{43,220}{277,903} = 0.16$ lb/10^6 Btu

SO_2 $\frac{689,846}{277,903} = 2.48$ lb/10^6 Btu

[1]Steam Electric Plant Air and Water Quality Control Data for the Year Ended December 31, 1972. Based on FPC Form No. 67. Summary Report FPC5-246 Washington, D.C.: Federal Power Commission, p. 1.

[2]Based on an average size unit 500 x 10^6 Btu/lb and State Regulations as published in the Environmental Reporter.

Table A-2. Allowable Emissions, Oil-Fired Steam-Electic Plants Based on Regulations for States Accounting for over 70 percent of Oil Consumption for Electric Generation

State	1972[1] Oil Consumption 10^3bbl	Emissions[2], lb/10^6Btu		Allowable Emission Weighted by Oil Consumption	
		Particulates	SO_2	Particulates	SO_2
California	41,352	0.33[3]	2.58[4]	13,646	106,688
Connecticut	27,618	0.20	0.55	5,524	15,190
Florida	62,347	0.10	1.1	6,235	68,582
Massachusetts	45,238	0.05	0.56	2,262	25,333
New Jersey	42,867	0.10	0.30	4,287	12,860
New York	78,232	0.10	0.80	7,823	62,586
Pennsylvania	23,773	0.11	2.1	2,615	49,923
Virginia	24,528	0.20	1.06	4,906	26,000
TOTAL	345,955			47,298	367,162
U.S. TOTAL	458,390				
%	75.5				

Particulate Material $\frac{47,298}{345,955} = 0.14$ lb/10^6Btu

SO_2 $\frac{367,162}{345,955} = 1.06$ lb/10^6Btu

[1]Steam Electric Plant Air and Water Quality Control Data for the Year Ended December 31, 1972. Based on FPC Form No. 67. Summary Report FPC5-246 Washington, D. C.: Federal Power Commission, p 1.

[2]Based on an average size unit 500 x 10^6 Btu/lb and State Regulations as published in the Environmental Reporter.

[3]Based on 0.2 gr/scfm

[4]Based on 0.2% by volume

The synthesized SIP controlled emission factors for Coal and Oil are different from those contained in the previous study [Ref. 1], because of changes to State regulations since the original study and the use of 1972 consumption data in place of 1971.

Activity Factors, 1975

Coal 405.95×10^6 tons [Ref. 3]
Oil 468.46×10^6 bbl [Ref. 3]

It should be noted that some of this activity is subject to NSPS. Assuming that any increase in 1975 activity over 1972 is in new facilities an estimate of this capacity can be obtained by comparing 1972 and 1975 activity data.

	Coal (10^6 tons)	Oil (10^3 bbl)
1975 Activity Factor	405.95	468.46
1972 Activity Factor [Ref. 4, p.1]	348.69	458.39
Capacity subject to NSPS	57.26	10.07

Estimated Actual 1975 Emissions

EPA Division of Stationary Source Enforcement compliance data indicates the following compliance states of coal and oil-fired steam-electric plants in 1975 [Ref. 5].

	Percent of Facilities in Compliance	
	Particulates	SO_2
Coal-fired	41	78
Oil-fired	92	83

Some of the plants in compliance are meeting NSPS emission limitations, others SIP emission limitations. The plants not in compliance are assumed to have the same degree of control as in 1970. These data and 1970, NSPS, and SIP emission factors can be used to estimate actual emissions for 1975. First the distribution of fuel by type of control must be determined.

Coal, Particulates:

1970 level $(1 - 0.41)(405.95) = 239.51 \times 10^6$ tons
SIP $348.69 - 239.51 = 109.18 \times 10^6$ tons
NSPS $405.95 - 348.69 = 57.26 \times 10^6$ tons

Coal, SO_2:

1970 level (1 - 0.78) (405.95) = 89.31 x 10^6 tons
SIP 348.69 - 89.31 = 259.38 x 10^6 tons
NSPS 405.95 - 348.69 = 57.26 x 10^6 tons

Oil, Particulates:

Because the NSPS (0.1 lb/10^6 Btu) and 5.0 (0.14 lb/10^6 Btu) emission limitations are greater than uncontrolled (0.054 lb/10^6 Btu), all oil combustion for 1975 is assumed to result in emissions of 0.054 lb/10^6 Btu.

Oil, SO_2:

1970 level (1 - 0.83) x (468.46) = 79.64 x 10^6 bbl
SIP 458.39 - 79.64 = 378.75 x 10^6 bbl
NSPS 468.46 - 458.39 = 10.07 x 10^6 bbl

Actual 1975 emissions are estimated to be:

	1970-Control	SIP-Control	NSPS-Control
Coal-Fired			
Particulates			
Activity Factor (10^6 tons)	239.51	109.18	57.26
Emission Factor (lb/10^6 Btu)	1.18	0.16	0.10
Emissions (10^3 tons)*	3,476	214	70
Total Particulate Emissions	3,476 + 214 + 70 = 3,760 x 10^3 tons.		
SO_2			
Activity Factor (10^6 tons)	89.31	259.38	57.26
Emission Factor (lb/10^6 Btu)	4.35	2.48	1.2
Emissions (10^3 tons)*	4,779	7,912	845
	4,779 + 7,912 + 845 = 13,536 x 10^3 tons		

*Calculated using 24.6 x 10^6 Btu/ton

Oil-Fired	
Particulates	**ALL**
Activity Factor (10^6 bbl)	468.46
Emission Factor (lb/10^6 Btu)	0.054
Emissions (10^3 tons)*	80

SO_2	1970-Control	SIP-Control	NSPS-Control
Activity Factor (10^6 bbl)	79.64	378.75	10.07
Emission Factor (lb/10^6 Btu)	1.61	1.06	0.8
Emissions (10^3 tons)*	403	1,264	25

Total SO_2 emissions 403 + 1,264 + 25 = 1,692 x 10^3 tons

*Calculated using 6.3 x 10^6 Btu/bbl

1975 Potential Emissions

Coal-Fired

	Particulates	SO_2
Activity Factor (10^6 tons)	405.95	405.95
Uncontrolled Emissions Factor (lb/10^6 Btu) [Ref. 1, p. A-5]	9.92	4.20
Uncontrolled Emissions (10^3 tons) (Assumed 24.6 x 10^6 Btu/ton)	49,532	20,971

Oil-Fired

Activity Factor (10^6 bbl)	468.46	468.46
Uncontrolled Emission Factor (lb/10^6 Btu) [Ref. 1, p. A-5]	0.054	1.37
Uncontrolled Emissions (10^3 tons) (Assumed 6.3 x 10^6 Btu/bbl)	80	2,022

Compliance Emissions

	SIP Control	NSPS
Coal-Particulates		
Activity Factor (10^6 tons)	348.69	57.26
Compliance Emission Factor (lb/10^6Btu)	0.16	0.10
Emissions (10^3 tons)	686	70
Total Particulates	756 x 10^3 tons	
Coal-SO_2		
Activity Factor (10^6 bbl)	348.69	57.26
Compliance Emission Factor (lb/10^6 Btu)	2.48	112
Emissions (10^3 tons)	10,636	845
Total SO_2	11,481 x 10^3 tons	
OIL-SO_2		
Activity Factor (10^6 bbl)	458.39	10.07
Compliance Emission Factor (lb/10^6 Btu)	1.06	0.08
Compliance Emissions (10^3 tons)	1,530	25
Total SO_2	1,555 x 10^3 tons	

References

Coal-Fired Steam-Electric Power Plants

1. Mascoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volume II: Research Triangle Park, N.C.; Research Triangle Institute, June 1975 (Task No. 21, EPA Contract 68-02-1325).

2. Standards of Performances for New Stationary Sources. 36 FR 247, December 23, 1971.

3. Personal Communication with Mr. M. Johnson. Federal Power Commission, Washington, D.C. May 21 1976.

4. Steam Electric Plant Air and Water Quality Control Data for the Year Ended December 31, 1972. Based on FPC Form No. 67. Summary Report FPC 5-246. Washington, D.C.: Federal Power Commission.

APPENDIX 3

INDUSTRIAL/COMMERCIAL COAL-FIRED BOILERS

1970

Baseline year data (1970) are as calculated in the initial study. Estimated actual emissions for 1970 are [Ref.1, p. B-7, B-8].

	10^3 tons	
	Industrial	Commercial
Particulates	2,435	110
SO_2	4,754	775

1975

Estimated Actual Emission Factors

Coal-fired industrial/commercial boilers were under two levels of control in 1975; 1970-level and SIP-level. The SIP control level has been reevaluated to reflect SIP changes in 1974. The following emission factors are applicable.

	Emission Factor (lb/ton)			
	Industrial		Commercial	
	Particulate	SO_2	Particulate	SO_2
1970 level [Ref.1, pp. B-4, B-5]	58.4	114	16.2	114
SIP level (See tables B-1, B-2)	8.64	52.9	8.9	67.3

Activity Factors 1975

Coal consumption in industrial and commercial boilers is expected to remain constant through 1980 at 70-75 x 10^6 tons and 15-20 x 10^6 tons respectively (Ref. 2, p.2). Midpoint data will be used.

Industrial Boilers	72.5 x 10^6 ton
Commercial Boilers	17.5 x 10^6 ton

Estimated Actual 1975 Emissions

EPA Division of Stationary Source Enforcement compliance data indicate that in 1975 fifty-two percent of coal-fired boilers, other than electrical generation units, were in compliance with emission limitations for particulate emissions and sixty-one percent for SO_2 emissions [Ref. 3]. The data are not broken down by commercial and industrial units. Therefore, this compliance data is assumed to be equally applicable to both commercial and

Table B-1. Estimated Nationwide Allowable Emissions. Coal-Fired Industrial Boilers.

STATE	1970 Coal[1] Consumption 10^3 tons	Particulates		SO_2	
		Allowable[2] lb/10^6 Btu	Weighted Allowable	Allowable[2] lb/10^6 Btu	Weighted Allowable
New York	5,659.6	0.37	2,094	1.20	6,792
Pennsylvania	7,711.9	0.27	2,082	2.67	20,591
Virginia	4,000.9	0.29	1,160	1.06	4,241
West Virginia	4,936.1	0.17	839	2.30	11,353
Michigan	7,922.6	0.30	2,377	2.20	17,430
Ohio	14,601.1	0.20	2,920	1.00	14,601
Indiana	6,418.4	0.80	5,135	6.00	38,510
Illinois	7,741.3	0.10	774	1.20	9,290
Wisconsin	4,096.7	0.15	615	1.20	4,916
TOTAL	63,088.6		17,996		127,724
TOTAL US	83,447.4				
%	75.6%				

Particulates: $\frac{17,996}{63,088.6} = 0.29$ lb/10^6 Btu

$26.2 \times 0.33 = 8.64$ lb/ton coal[3]

SO_2: $\frac{127,724}{63,088.6} = 2.02$ lb/10^6 Btu

$26.2 \times 2.02 = 52.9$ lb/ton coal[3]

[1]Projection of the Effectiveness and Costs of a National Tax on Sulfur Emissions. Research Triangle Institute, November 1973, pp. 96-98.

[2]Based on a 100 x 10^6 Btu/hr plant and State regulations as published in Environmental Reporter

[3]Assumes 26.2 x 10^6 Btu/ton (Background Information for Establishment of National Standards of Performance for New Sources--Industrial Size Boilers. Walden Research Corporation, June 1971, p.4-2)

Table B-2. Estimated Nationwide Allowable Emissions.
Coal-Fired Commercial Boilers.

	1970 Coal[1] Consumption 10^3 tons	Particulates		SO_2	
		Allowable[2] lb/10^6 BTU	Weighted Allowable	Allowable[2] lb/10^6 BTU	Weighted Allowable
Pennsylvania	600	0.4	240	3.0	1,800
Virginia	500	0.3	150	1.06	530
North Carolina	500	0.7	350	2.3	1,150
Michigan	900	0.3	270	2.2	1,980
Ohio	1,500	0.4	600	1.0	1,500
Indiana	600	0.8	480	6.0	3,600
Illinois	2,800	0.1	280	1.8	5,040
Wisconsin	1,600	0.15	240	1.2	4,640
Minnesota	900	0.6	540	2.5	3,600
Kentucky	500	0.56	280	4.0	2,000
Tennessee	600	0.6	360	4.0	2,400
TOTAL	11,000		3,790		28,240
TOTAL U.S.	13,567				
%	81%				

Particulates: $\frac{3,790}{11,000} = 0.34$ lb/10^6 BTU

$26.2 \times 0.34 = 8.91$ lb/ton coal[3]

SO_2 $\frac{28,240}{11,000} = 2.57$ lb/10^6 BTU

$26.2 \times 2.57 = 67.3$ lb/ton[3]

[1]Projections of the Effectiveness of a National Tax on Sulfur Emissions. Research Triangle Institute, November 1973, pp. 96-98.

[2]Based on a 10×10^6 BTU/hr plant and State Regulations as published in The Enivronmental Reporter.

[3]Assumes 26.2×10^6 BTU/ton (Background Information for Establishment of National Standards of Performances for New Sources--Industrial Size Boilers, Walden Research Corporation, June 1971, p. 4-2).

industrial boilers. Distribution of fuel in 1975 by type of control is determined to be:

	10^6 tons	
	Commercial	Industrial
Particulates		
1970-level	8.4	34.8
SIP-level	9.1	37.7
SO_2		
1970-level	6.8	28.3
SIP-level	10.7	44.2

Actual 1975 emissions are estimated to be:

Industrial Boilers	1970 Control	SIP Control
Particulates		
Activity Factor (10^6 tons)	34.8	37.7
Emission Factor (lb/ton)	58.4	8.64
Emissions (10^3 tons)	1,016	163
Total particulates	1,016 + 163 = 1,179 x 10^3 tons	
SO_2		
Activity Factor (10^6 tons)	28.3	44.2
Emission Factor (lb/ton)	114	52.9
Emission (10^3 tons)	1,613	1,169
Total SO_2 emissions	1,613 + 1,169 = 2,782 x 10^3 tons	

Commercial Boilers	1970 Control	SIP Control
Particulates		
Activity Factor (10^6 tons)	8.4	9.1
Emission Factor (lb/ton)	16.2	8.91
Emissions (10^3 tons)	68	40
Total particulates	68 + 40 = 108 x 10^3 tons	
SO_2		
Activity Factor (10^6 tons)	6.8	10.7
Emission Factor (lb/ton)	114	67.3
Emissions (10^3 tons)	388	360
Total SO_2 emissions	388 + 360 = 748 x 10^3 tons	

1975 Potential Emissions

	Particulates	SO_2
Industrial Boilers		
Activity Factor (10^6 tons Coal)	72.5	72.5
Emission Factor (lb/ton) [Ref. 1, p. B-4]	105.3	114.0
Emissions (10^3 ton)	3,817	4,133
Commercial Boilers		
Activity Factor (10^6 tons Coal)	17.5	17.5
Emission Factor (lb/ton) [Ref. 1, p. B-4]	16.2	114
Emissions (10^3 ton)	142	998

Total:

Particulates	3,817 + 142 = 3,959
SO_2	4,133 + 998 = 5,131

Compliance Emissions

	Particulates	SO_2
Industrial Boilers		
Activity Factor (10^6 tons coal)	72.5	72.5
Compliance Factor (lb/ton) [Ref. 1, p. B-7]	8.91	60.0
Emissions (10^3 tons)	323	2,175
Commercial Boilers		
Activity Factor (10^6 tons coal)	17.5	17.5
Compliance Factor (lb/ton) [Ref. 1, p. B-8]	8.91	70
Emissions (10^3 tons)	78	613

Total:

Particulates	323 + 78 = 401 x 10^3 tons
SO_2	2,175 + 613 = 2,788 x 10^3 tons

Industrial/Commercial Coal-Fired Boilers

List of References

1. Massoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volume II: Research Triangle Park, N.C.; Research Triangle Institute, June 1975 (Task No. 21, EPA Contract 68-02-1325).

2. Background Information on Coal-Fired Industrial Boilers, Washington, D.C.: Division of Stationary Source Enforcement, Environmental Protection Agency, September 5, 1974.

3. Provided by the EPA Project Monitor.

APPENDIX C

PORTLAND CEMENT PLANTS

1970

Baseline year data, 1970, are as calculated in the initial study. Estimated actual particulate emissions for 1970 are estimated to be [Ref.1, p. C-8].

Particulates	906×10^3 tons
SO_2	733×10^3 tons

1975

Estimated Actual Emission Factors

Portland cement plants were under three levels of control in 1975. Plants coming onstream since 1972 were subject to NSPS and can be assumed to be in compliance therewith. Some of the 1972 plants in place were in compliance with SIP emissions limitations. The remainder were emitting at the average 1970 rate.

SIP control level has been recalculated to reflect SIP changes since 1974 and more current production data. The following emission factors are applicable.

	+ lb/ton	
	Particulates	SO_2
1970 [Ref.1, p. C-8]	23.67	19.15
NSPS [Ref.2]	0.60	None
SIP Control (See table C-1)	1.92	19.15

*Includes 0.96 lbs. from kilns and 0.96 lbs. from clinker coolers.

Table C-1. Allowable Particulate Emissions, Portland Cement Industry. Based on States having over 75 Percent of 1973 Capacity.

State	1973[1] Production 10^3 Tons	Number[1] of Plants	Process Rate Average-Plant[2] Tons/hr	Allowable Emissions[2] lb/hr	Total Allowable lb/hr	Total Process Rate tons/hr
Alabama	2,393	7	65.0	33.8	236.6	455.0
California	9,262	13	135.6	47.2[4]	613.6	1,762.8
Florida	2,182	4	103.8	36.4	145.6	415.2
Illinois	1,419	3	90.0	50.2	150.6	270.0
Indiana	2,118[5]	6[5]	67.2	123.0	738.0	403.2
Iowa	2,436	5	92.7	51.6	258.0	463.5
Kansas	1,930	5	73.4	50.5	252.5	367.0
Michigan	4,805	6	152.4	55.6	333.6	914.4
Missouri	4,154	7	112.9	52.5	367.5	790.3
New York	5,354	10	101.9	56.3	563.0	1,019.0
Ohio	3,074	8	73.1	41.2	329.6	584.8
Pennsylvania	8,294	17	92.8	64.0	1,088.0	1,577.6
Tennessee	1,660	6	52.6	32.6	195.6	315.6
Texas	7,853	18	83.0	90.3	1,625.4	1,494.0
Total	56,934	115			6,897.6	10,832.4
U.S. Total	78,212	166				
%	72.7	69.3				

Allowable Emissions

$$\frac{6,897.6}{(10,832.4 \div 1.5)} = 0.96 \text{ lb/ton}$$

[1]Minerals Yearbook, U.S. Bureau of Mines, 1973, p. 255.

[2]Based on ratio of fuel to product of 1.5 as calculated from EPA data (Background Information for Proposed New Source Performance Standards. Environmental Protection Agency, August 1971) and 7,884 hours per year operation.

[3]From State Regulations as reported in The Environmental Reporter.

[4]Average of Los Angeles and San Francisco Process Rate Regulations.

[5]Estimated from data in reference 1 above.

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Activity Factors, 1975

$68,993 \times 10^3$ tons [Ref. 4].

It should be noted that some of this activity is subject to NSPS. Assuming that any increase in 1975 activity over 1973 was new facilities. An estimate of this capacity can be obtained by comparing activity levels for these two years.

1975 Activity Factor	68.993×10^3 tons [Ref.4]
1972 Activity Factor	78.212×10^3 tons [Ref.3, p. 255]
Under NSPS	None

Estimated Actual 1975 Emissions

EPA Division of Stationary Source Enforcement compliance data indicates that 68 percent of the Portland cement plants were in compliance with emission limitations in 1975 [Ref.5]. Applying this figure to the 1975 reported production results in the following distribution by level of control

1970-level	$(1-0.68)\ (68,993) = 22,078 \times 10^3$ tons
SIP-level	$(0.68)\ (68,993) = 46,915 \times 10^3$ tons

Actual 1975 emissions are estimated to be:

	1970 Control	SIP Control
Particulates		
Activity Factor (10^3 tons)	22,078	46,915
Emission Factor (lb/ton)	23.67	1.92
Emissions (10^3 ton)	261	45
Total particulate emissions	261 + 45 =	305×10^3 tons

SO_2

All Activity is considered uncontrolled for SO_2

Total SO_2 emissions $68,993 \times 19.15 \div 2000 = 661 \times 10^3$ tons

1975 Potential Emissions

Uncontrolled Emission Factors - Particulates 278.4 lb/ton[Ref.1, p.C-4]
SO_2 11.9 lb/ton[Ref.1, p.C-4]

Particulates	$68,993 \times 10^3 \times 278.4 \div (2000) = 9,604 \times 10^3$ tons
SO_2	$68,993 \times 10^3 \times 19.15 - (2000) = 661 \times 10^3$ tons

Compliance Emissions

Particulates

Activity Factor	$68{,}993 \times 10^3$ tons
Emission Factor	1.92 lb/ton
Emissions	$68{,}993 \times 1.92 \div 2{,}000 = 66 \times 10^3$ tons

SO_2

Activity Factor	$68{,}993 \times 10^3$ tons
Emission Factor	19.15 lb/ton

$68{,}993 \times 19.15 \times 2{,}000 = 661 \times 10^3$ tons

PORTLAND CEMENT PLANTS

List of References

1. Massoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volume II: Research Triangle Park, N.C.; Research Triangle Institute, June 1975 (Task No. 21, EPA Contract 68-02-1325).

2. 36 FR 24 880, December 23, 1971.

3. Minerals Yearbook 1972. Washington, D.C.: U.S. Bureau of Mines.

4. Personal communication with Mr. Avery Reed, U.S. Bureau of Mines, May 11, 1976.

5. Provided by EPA Project Monitor.

APPENDIX D

PETROLEUM REFINERIES

(Particulates and SO_2)

Major sources of particulate and SO_2 emissions from petroleum refinery operations are from catalytic cracking operations and combustion operations [Ref.1, p.31]. Claus sulfur recovery units using refinery gases as feedstocks are also a significant source of SO_2 emissions.

For the purposes of this analysis, petroleum refinery operations will include any associated Claus sulfur recovery units. The reduction in SO_2 emissions that would otherwise occur if the refinery off-gases were flared, is not considered a reduction resulting from emission limitations required under Federal and State programs. Recovery of sulfur from off-gases is profitable if the price of sulfur is greater than $5.88 per long ton [Ref.2, p.130]. For the purposes of this analysis, it is assumed that during 1970-1975, with the exception of small independent refineries, Claus capacity at petroleum refineries was sufficient to process all off-gases generated during refinery operations.

It should be noted that emission from Claus units are subsumed under chemical processes in the NEDS inventories rather than under petroleum refineries. Fluid coking operations can also result in particulate and SO_2 emissions. However, this process is not economically attractive unless the fuel oil market is weak. [Ref.1, p.20]. Increased demands for energy will most likely result in an increased demand for residual fuel oil with suppression of fluid coking. Therefore, for the purposes of this analysis, fluid coking processes will not be considered.

EMISSION FACTORS

Uncontrolled

Particulates [Ref. 3, p.9.1-3]	
Boilers and Process Heaters	840 lb/10^3 bbl oil burned
Fluid Catalytic Cracking	242 lb/10^3 bbl fresh feed
Moving Bed Catalytic Cracking	17 lb/10^3 bbl fresh feed
SO_2 [Ref.3, p. 9.1-3; p. 5.18-3]	
Boilers and Process Heaters	6,720 S lb/10^3 bbl oil burned
Fluid Catalytic Cracking	493 lb/10^3 bbl fresh feed
Moving Bed Catalytic Cracking	60 lb/10^3 bbl fresh feed
Claus Sulfur Recovery Units (average of two stage unit)	280 lb/ton sulfur recovered

These factors can be converted to a basis of 10^3 bbl crude processed.

1. Boilers and Process Heaters

In 1967 1,160.677 x 10^{12} Btu from oil combustion were used in the petroleum industry [Ref.4] to process 3,582.6 x 10^6 bbl of crude [Ref. 5, p.166]. Using a heat content of 6,000 x 10^6 Btu/10^3 bbl of oil, 2nd sulfur content of 1.0% [Ref. 1, p. 4], uncontrolled emissions per 10^3 bbl crude processed are calculated as being:

Particulates:

$$\frac{840 \times 1{,}160.677 \times 10^{12} \times 10^3}{6{,}000 \times 10^6 \times 3{,}582.6 \times 10^6} = 45.4 \text{ lb}/10^3 \text{ bbl crude}$$

SO:

$$\frac{6{,}720 \times 1 \times 1{,}160.677 \times 10^{12} \times 10^3}{6{,}000 \times 10^6 \times 3.582.6 \times 10^6} = 363 \text{ lb}/10^3 \text{ bbl crude}$$

2. Catalytic Cracking

In 1970 and 1971 86.6 percent of production was by the fluid bed system [Estimated from data in Ref. 6, p.69, and Ref. 7, p. 81]. This same ratio will be used through 1975. Approximately 45 percent of crude is processed by catalytic cracking [Ref.1, p.14].

Particulates:

$$[(242 \times 0.886) + (17 \times 0.114)] \times 0.45 = 97.4 \text{ lb}/10^3 \text{ bbl crude}$$

SO_2:

$$[(493 \times 0.886) + (60 \times 0.114)] \times 0.45 = 198 \text{ lb}/10^3 \text{ bbl crude}$$

3. Claus Sulfur Recovery Units

For each ton of sulfur recovered, 1.1 tons of input sulfur are required [Ref.8, p.4]. Approximately 40.5 percent of sulfur input to refinery operation remains in the petroleum products [Ref.2, p.104]. Percentages of input sulfur recoverable in Claus recovery units has been reported as 27 percent [Ref.2, p.104], 50 percent [Ref. 9] and 87 percent [Ref.1, p.29]. For the purpose of this analysis, the 50 percent figure will be used. Using these data, a one percent average crude sulfur content [Ref.1, p.4] and a crude density of 336 pounds/barrell [Ref. 3, p.9.1-5], the crude equivalent of one ton of recovered sulfur can be calculated as being:

$$\frac{2{,}000 \times 1.1}{0.01 \times 0.50 \times 336} = 1{,}310 \text{ bbls}$$

The uncontrolled emission factor for Claus units converts to

$$\frac{280 \times 10^3}{1{,}310} = 214 \text{ lb}/10^3 \text{ bbls}$$

4. Sulfur Balance

The uncontrolled emission factors calculated in the preceding paragraphs can be validated by a sulfur material balance

Basis 1,000 bbl crude

		Pounds of Sulfur
Input		
1,000 x 336 x 0.01		3,360
Output		
Catalytic Cracking	$\frac{198}{2}$	99
Combustion and Process Heat	$\frac{363}{2}$	181.5
Claus Plant Emissions	$\frac{214}{2}$	107
Sulfur Recovery	$\frac{2{,}000}{1.310}$	1,527
In Products	3,360 x 0.405	1,361
Unaccounted		84.5

Emissions from existing coking operations, and sulfur in solid and liquid wastes could amount for at least part of the unaccounted for sulfur. The validation by the sulfuric balance is considered adequate for the purposes of this analysis.

5. Recapitulation

Uncontrolled Emission Factors

	lb/10^3 bbl crude processes	
	Particulates	SO_2
Catalytic Crackers	97.4	363
Boilers and Process Heaters	45.4	198
Claus Recovery Systems	--	214
Total	142.8	775

Controlled Emissions

Particulates

Synthesized nationwide allowable emission factors for catalytic cracking and fuel combustion based on regulations for states having 70% of national refinery capacity are calculated as being (table D-1)

Catalytic cracking	19.1 lb/10^6 bbl crude
Combustion	0.31 lb/10^6 Btu

Using the same data as used for uncontrolled emissions, the emission factor for combustion sources converts to 100.4 lb/10^3 bbl crude.

$$\frac{0.31 \times 1{,}160{,}677{,}000}{3{,}582{,}600} = 100.4$$

This is larger than the uncontrolled emissions factor. Controlled factor is assumed to be the same as uncontrolled for combustion processes.

All sources 45.4 + 19.1 = 64.5 lb/10^3 bbl crude

New sources performance standards for particulate emissions from catalytic

Table D-1. Allowable Particulate Emissions, Petroleum Refinery Operations. Based on regulations for States having over 70 percent of national crude capacity.

State	1975 Capacity[1] bbl/day	Catalytic Cracking		Combustion Processes	
		Allowable Emissions[2] lb/hr	Weighted by Capacity[5]	Allowable Emissions[6] 10^6/Btu	Weighted by Capacity[5]
California	1,903,935	49.3[3]	9,386	0.2[7]	38.08
Illinois	1,176,050	58.5	6,880	0.1	11.77
Indiana	561,160	58.5	3,282	0.4	22.45
Louisiana	1,753,095	58.5	10,256	0.6	105.19
Ohio	589,770	58.5	3,450	0.2	11.80
Oklahoma	545,775	58.5	3,193	0.35	19.10
Pennsylvania	575,020	33.1	2,506	0.27	20.44
Texas	5,966,330	91.1[4]	36,133	0.3[8]	118.99
TOTAL	11,253,135		75,087		347.82
U.S. TOTAL	15,074,845				
%	74.6				

Catalytic Cracking

$$\frac{75,087 \times 10^4 \times 24}{11,253,135 \times 31.8} \times 0.38 = 19.1 \text{ lb}/10^3\text{bbl}$$

Combustion Process

$$\frac{347.82 \times 10^4}{11,253,135} = 0.31 \text{ lb}/10^6 \text{ Btu}$$

[1] "Summary of Operating Capacities in the U.S.," The Oil and Gas Journal. Vol. 79, No. 13, March 29, 1976, p. 129.

[2] Based on an average throughput of 31,800 bbl/day (Petroleum Refinery Background Information for Establishment of Federal Standards for the Performance of Stationary Sources. Process Research Inc., August 1974, p. 19) and regulations as published in The Environmental Reporter.

[3] Average Los Angeles and California Process Rate Curves.

[4] Based on 90,000 scfm and temperature 600° F (calculated from Background Information for Proposed New Source Performance Standards, Environmental Protection Agency, June 1973, p.18).

[5] (bbl/calendar day) x (allowable emissions) ÷ 10^4.

[6] Based on average boiler size, 100 x 10^6 Btu hr. and regulations as published in The Environmental Reporter.

[7] Estimated from previous RTI work on PRMS.

[8] Analyses of Final State Implementation Places--Rules and Regulations. APTD-1334 Environmental Protection Agency, July 1972.

converters and combustion processes were promulgated in March 1974. It will be assumed that the NSPS will not be applicable to new refinery capacity until after 1975.

SO_2

NADB considers SO_2 emissions from refinery operations to be relatively uncontrolled. Claus plants are considered as control techniques for SO_2 emissions for off-gases from other than catalytic crackers and combustion process [Ref.9]. Analysis of State regulations for SO_2 emissions from catalytic crackers and combustion processes indicates that no controls are required for these processes. For sulfur recovery units, EPA estimates that reasonable available control technology will permit limitation of SO_2 emissions to 0.01 pound per pound of sulfur processed (1,300 ppm) [Ref. 1, p.50]. This figure, assumed to represent SIP requirement, converts to crude input as follows:

$$\frac{0.01 \times 1.1 \times 2{,}000}{\frac{0.01 \times 1.1 \times 2{,}000 \times 10^3}{1{,}310}} = \frac{\text{pounds } SO_2/\text{ton of S recovered}}{17 \text{ pound}/10^3 \text{bb/crude}}$$

Total controlled SO_2 Emission	lb/10^3 bbl crude
Claus Plants	17
Catalytic Crackers	363
Boilers and Combustion Processes	198
Total	578

ACTIVITY FACTORS

1970	3,967.5 x 10^6 bbl crude [Ref.4, p.166]
1975	4,539.14 x 10^6 bbl crude [Ref. 10]

DEGREE OF CONTROL

	1970
Particulates	68.4 lb/10^6 bbl crude [Ref.11, p.D-8]
SO_2 Process and Combustion	532 lb/10^3 bbl crude Uncontrolled [Ref. 9]

1970

Particulate emissions in 1970 are estimated to be:

	Actual	Potential
Activity Factor (10^6 bbl crude)	3,967.5	3,967.5
Emission Factor (lb/10^3 bbl)	684 [Ref.11, p.12-8]	142.8
Emissions (10^3 tons)	136	283

SO_2 emissions in 1970 are estimated to be:

	Actual	Potential
Activity Factor (10^6 bbl crude)	3,967.5	3,967.5
Emission Factor (lb/10^3 bbl)	775	775
Emissions (10^3 ton)	1,537	1,537

1975

EPA Division of Stationary Source Enforcement compliance data indicates that 81 percent of petroleum refineries as a source were in compliance with emissions regulations as in 1975 [Ref.1] . It is assumed that these compliance data are equally applicable to particulates and SO_2. Actual 1975 emission factors can be estimated as follows:

Particulates:

$$(1-0.81)(68.4) + (0.81)(64.5) = 65.2 \text{ lb}/10^3 \text{ bbl crude}$$

SO_2:

$(1-0.81)(1,007) + (0.81)(578) = 660$ lb/10^3 bbl crude (Assumes all off gases processed through sulfur recovery units.)

1975 actual emissions are estimated to be:

	Particulates	SO_2
Activity Factor (10^6 bbl crude)	4,539.14	4,539.14
Emission Factor (lb/10^3 bbl crude)	65.2	660
Emissions (10^3 tons)	148	1,498

1975 potential emissions are estimated to be:

	Particulates	SO_2
Activity Factor (10^6 bbl crude)	4,539.14	4,539.14
Emission Factor (lb/10^3 bbl crude)	142.8	775
Emissions (10^3 tons)	324	1,759

Compliance Emissions

	Particulates	SO_2
Activity Factor (10^6 bbl crude)	4,539.14	4,539.14
Emission Factor (lb/10^3 bbl crude)	64.5	578
Emissions (10^3 tons)	146	1,312

PETROLEUM REFINERIES

List of References

1. Atmospheric Emissions from The Petroleum Refining Industry. Research Triangle Park, N.C.: Environmental Protection Agency, August 1973. EDA

2. Russell, Cliford S., Residuals Management in Industry: A Case Study of Petroleum Refining. Baltimore: The Johns Hopkins University Press, 1973 (Published for Resources for the Future, Inc.).

3. Compilation of Air Pollutant Emission Factors, AP-42, Second Edition (with changes 1-5). Research Triangle Park, N.C.: Environmental Protection Agency, December 1975.

4. An Analysis of the Materials and Natural Resources Requirements and Residuals Generation of Personal Consumption Expenditures. Draft Final Report. Research Triangle Park, N.C.: Research Triangle Institute, April 1975 (For EPA Office of Solid Waste Management under Contract 68-01-2448).

5. 1971 Business Statistics, U.S. Department of Commerce.

6. OAQPS Data File of Nationwide Emissions, 1970. Research Triangle Park, N.C.: Environmental Protection Agency, April 1973.

7. OAQPS Data File of Nationwide Emissions, 1971. Research Triangle Park, N.C.: Environmental Protection Agency, May 1973.

8. Petroleum Refinery Background Information for Establishment of Standards of Performance for Stationary Sources, Process Research, Inc., August 1974.

9. Personal communication with Mr. C. Mann, EPA/Durham, June 1, 1976.

10. Personal communication with Mr. D. Lange, Oil and Gas Journal, May 14, 1976.

11. Massoglia, Martin F., Summary of Emission Reduction Achieved Nationwide by Selected Source Categories, Volume II. Research Triangle Park, N.C.: Research Triangle Institute, June 1975 (Prepared for DSSE under Task 21, Contract 68-02-1325).

12. Unpublished EPA Data Provided RTI in conjunction with work under Task Order 15, Contract 68-02-0607).

13. Provided by EPA Project Monitor.

APPENDIX E

MUNICIPAL REFUSE INCINERATORS

(Particulates Only)

1970

Baseline year data (1970) are as previously calculated in the initial study and are estimated as being 105 x 10^3 tons [Ref. 1, p. E-3].

1975

Estimated Actual Emission Factors

Municipal incinerators in 1975 were under two levels of control: 1970-level and SIP-level. The emission factors used in the initial study are considered to represent the most current SIP data and are used herein.

1970-level [Ref.1, p. E-6]	17.2 lb/ton
SIP-level [Ref.1, p. E-6]	2.4 lb/ton

Activity Factor

1975 13.5×10^6 tons [Ref. 2]

Estimated Actual 1975 Emissions

EPA Division of Stationary Source Enforcement compliance data indicate that 43 percent of municipal incinerators were in compliance with emission limitations in 1975. Activity can be distributed to level of control as follows:

1970-level [1-0.43][13.5] = 7.7×10^6 tons
SIP-level [0.43] [13.5] = 5.8×10^6 tons

Actual 1975 emissions are estimated to be:

	1970-level	SIP-level
Activity Factor (10^6 tons)	7.7	5.8
Emission Factor (lb/ton)	17.2	2.4
Emissions (10^3 tons)	66.2	7.0

Total: 73.2 x 10^3 tons

1975 Potential Emissions

Activity Factor (10^6 tons)	13.5
Emission Factor (lb/ton)[Ref.3, p. 2.1-3]	30
Emissions (10^3 tons)	203

Compliance Emissions

Activity Factor (10^6 tons)	13.5
Emission Factor (lb/ton)	2.4
Emissions (10^3 tons)	16

MUNICIPAL REFUSE INCINERATORS

List of References

1. Massoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volume II: Research Triangle Park, N.C.; Research Triangle Institute, June 1975 (Task No. 21, EPA Contract 68-02-1325).

2. Personal communication with Mr. S. Hitte, Office of Solid Waste Programs, Environmental Protection Agency, May 17, 1976.

3. Compilation of Air Pollutant Emission Factors AP-42 (with changes 1-5). Research Triangle Park, N.C.: Environmental Protection Agency, December 1975.

APPENDIX F

SULFURIC ACID PLANTS

(SO_2 Only)

1970

Baseline year data (1970) are as previously calculated in the initial study. Estimated actual emissions for 1970 are 581 x 10^3 tons SO_2 [Ref. 1, p. F-3].

1975

Estimated Actual Emission Factors

Sulfuric acid production in 1975 was under four levels of control: 1970-level; SIP level, SIP new source level for plants coming onstream 1970-1972, and NSPS level for plants coming onstream after 1972. The following emission factors are applicable.

	SO_2/ton 100% acid
1970-level [Ref. 1, p. F-6]	40
SIP-level [Table F-1]	12.0
SIP-level, New Plants [Table F-1]	8.8
NSPS [Ref. 2]	4.0

The SIP emission factor has been recalculated to reflect SIP changes since the initial study.

Activity Factors

	10^6 tons 100% acid
1970 [Ref.3, p. 125]	29.0
1972 [Ref.4, p. 125]	31.0
1975 [Ref.5]	31.3

Thus 2.0 x 10^6 tons were produced under SIP new source controls and 0.3 x 10^6 tons under NSPS.

Table F-1. Allowable SO_2 Emission Factors, Sulfuric Acid Plants. Based on Regulations for States Having over 75 Percent of National Capacity

State	1973[1] Capacity 10^3 tons	Allowable Emissions[2]		Weighted by Capacity	
		Existing Plants	New Plants	Existing Plants	New Plants
Arizona	2,573	4.0	4.0	10,292	10,292
California	2,332	6.5	6.5	15,158	15,158
Florida	15,323	10.0	4.0	153,230	61,292
Idaho	1,489	28.0	4.0	41,692	5,956
Illinois	1,570	4.0	4.0	6,280	6,280
Louisiana	6,361	6.5	6.5	41,347	41,347
New Jersey	1,915	6.5[3]	6.5[3]	12,448	12,448
North Carolina	2,257	27.0	27.0	60,939	60,939
Pennsylvania	937	6.5	6.5	6,091	6,091
Tennessee	1,260	6.5	4.0	8,190	5,040
Texas	4,274	30.0	30.0	128,220	128,220
Total	40,291			483,887	353,063
US	42,878				
%	94.0				

Existing Plants $\frac{483,887}{40,291}$ = 12.00 lb/ton New Plants $\frac{353,063}{40,291}$ = 8.76 lb/ton

[1]Chemical Economics Handbook, Stanford Research Institute, February 1976, pp. 780, 1003B-U.

[2]Based on State Regulations as published in The Environmental Reporter.

[3]Analyses of Final State Implementation Plans--Rules and Regulations APTD 1334. Environmental Protection Agency, July 1972.

Estimated Actual 1975 Emissions

EPA Division of Stationary Source Enforcement compliance data indicate that 62 percent of the sulfuric acid plants were in compliance with emission limitations in 1975 [Ref. 6]. Some of the plants in compliance are meeting NSPS or SIP new source standards. The remainder SIP existing source requirements. The plants not in compliance are assumed to have the same degree of control as in 1970. Following is the distribution of 1975 production by level of control.

1970-level (1-0.62)(31.3) =	11.9×10^6 tons
SIP-new source level	2.0×10^6 tons
NSPS	0.3×10^6 tons
SIP-existing sources level	17.1×10^6 tons

Actual 1975 emissions are estimated to be:

	1970	SIP New	SIP	NSPS
Activity Factor (10^6 tons)	11.9	2.0	17.1	0.3
Emission Factor (lb/ton)	40	8.8	12.0	4.0
Emissions (10^3 tons)	238.0	8.8	102.6	0.6

Total Emissions $238.0 + 8.8 + 102.6 + 0.6 = 350 \times 10^3$ tons

1975 Potential Emissions

Activity Factor (10^6 tons)	31.3
Uncontrolled Emission Factor (lb/ton) [Ref.7, p. 5.17-5]	40
Potential Emissions (10^3 tons)	626

Compliance Emissions

	SIP-existing	SIP-new	NSPS
Activity Factor (10^6 tons)	29.0	2.0	0.3
Emission Factor (lb/ton)	12.0	8.8	4
Emissions (10^3 tons)	174.0	8.8	0.6

Total $174.0 + 8.8 + 0.6 = 183.4 \times 10^3$ tons

SULFURIC ACID PLANTS

List of References

1. Massoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected INdustrial Source Categories, Volume II: Research Triangle Park, N.C.; Research Triangle Institute, June 1975 (Task No. 21, EPA Contract 68-02-1325).

2. 36 FR 24881, December 23, 1971.

3. 1971 Business Statistics, U.S. Department of Commerce.

4. 1973 Business Statistics, U.S. Department of Commerce.

5. Chemical Economics Handbook. Stanford Research Institute, February 1976.

6. Provided by EPA Project Monitor.

7. Compilation of Air Pollutant Emission Factors, AP42, Second Edition (with changes 1-5), Research Triangle Park, N.C.: Environmental Protection Agency, December 1975.

APPENDIX G

PHOSPHATE FERTILIZER PLANTS

(Particulate Emissions Only)

1970

Baseline year data (1970) are as calculated in the initial study. Estimated actual particulate emissions for 1970 are [Ref. 1, pp. G-9, G-10].

	$\frac{10^3 \text{ tons}}{10}$
Diammonium Phosphate (Process)	less than 1
Normal Super Phosphate (Process)	14
Rock Pulverization	

1975

Estimated actual emission data

Phosphate fertilizer plants in 1975 were under two levels of control, 1970-level and SIP-level. SIP-level has been recalculated to reflect changes in SIP regulations since 1974 and more current production data [Table G-1]. The following emission factors are applicable:

	Emission Factors (lb/Ton P_2O_5)	
	1970-level	SIP-level
Diammonium Phosphate (Process)	8.2 [Ref.1, p.G-7]	1.41 [See table G-1]
Normal Superphosphate	0.9 [Ref.1, p.G-7]	6.09 [Ref.1, p. G-4]
Rock Pulverization	4.3 [Ref.1, p.G-7]	3.19 [Ref.1, p. G-6]

Activity Factors 1975

Diammonium Phosphate	2.552×10^6 Tons P_2O_5 [Ref. 2]
Normal Superphosphate	0.484×10^6 Tons P_2O_5 [Ref. 2]
Rock Pulverization	6.72×10^6 Tons P_2O_5

Rock pulverization activity factor estimated by scaling up 1970 data by ratio of diammonium phosphate production 1975 to 1970.

1970 Diammonium phosphate production	2.43×10^6 tons P_2O_5 [Ref.3,Table 1.1]
1975 Diammonium phosphate production	2.52×10^6 tons P_2O_5 [Ref.2]
1970 Rock Pulverization Activity	6.4×10^6 tons P_2O_5 [Ref.3, Table 1.1]

Estimated 1975 Rock Pulverization Activity

$$6.4 \times \frac{2.552}{2.43} = 6.72 \times 10^6 \text{ tons } P_2O_5$$

Estimated Actual 1975 Emissions

EPA Division of Stationary Source Enforcement Compliance data indicates that 87 percent of the phosphate fertilizer sources were in compliance with emission limitations in 1975 [Ref. 4]. The data are not broken down by process. It will be assumed that the compliance data are applicable to all operations. Applying this compliance figure to 1975 activity data results in the following distribution of activity by control level.

	10^6 Tons P_2O_5	
	SIP-level	1970-level
Diammonium Phosphate	2.221	0.331
Normal Superphosphate	0.421	0.063
Rock Pulverization	5.85	0.87

Actual 1975 emissions are estimated to be:

Diammonium phosphate	1970 Control	SIP Control
Activity Factor (10^6 tons P_2O_5)	0.331	2.221
Emission Factor (lb/ton P_2O_5)	8.2	1.41
Emissions (10^3 tons)	1	2

Total particulate emissions 3×10^6 tons

Normal Superphosphate		
Activity Factor (10^6 tons P_2O_5)	0.063	0.421
Emission Factor (lb/tons P_2O_5)	<1	<1

Total particulate emissions <1

Rock pulverization		
Activity Factor (10^6 tons P_2O_5)	0.87	5.85
Emission Factor (lb/ton P_2O_5)	4.3	3.19
Emissions (10^3 tons)	1.9	9.3

Total particulate emissions $1.9 + 9.3 = 11.2 \times 10^3$ tons

Particulate emissions - all sources $3 + 11.2 = 14 \times 10^3$ tons

1975 Potential Emission

Activity Factors

Diammonium phosphate	2.252×10^6 tons P_2O_5
Normal Superphosphate	0.484×10^6 tons P_2O_5
Rock Pulverization	6.72×10^6 tons P_2O_5

Uncontrolled Emission Factors

Diammonium phosphate	82 lb/ton P_2O_5 [Ref. 5, p.6.10-1-2]
Normal superphosphate	9 lb/ton P_2O_5 [Ref. 5, p.6.10-1]
Rock Pulverization	21.5 lb/ton P_2O_5 [Ref.1, p.G-4]

Potential Emissions

Diammonium phosphate	$2.25 \times 10^6 \times 82 \div (2{,}000 \times 1{,}000) = 92.3 \times 10^3$ tons
Normal Superphosphates	$0.84 \times 10^6 \times 9 \div (2{,}000 \times 1{,}000) = 2.2 \times 10^3$ tons
Rock Pulverization	$6.72 \times 10^6 \times 21.5 \div (2{,}000 \times 1{,}000) = 72.4 \times 10^3$ tons
Total	166.9×10^3 tons

Compliance Emissions

Activity Factors

Diammonium phosphate	2.252×10^6 tons P_2O_5
Normal Superphosphate	2.484×10^6 tons P_2O_5
Rock Pulverization	6.72×10^6 tons P_2O_5

Compliance Emission Factors

Diammonium phosphate	1.51 lb/ton P_2O_5
Normal Superphosphate	0.09 lb/ton P_2O_5
Rock Pulverization	3.19 lb/ton P_2O_5

Emissions

Diammonium Phosphate	$2.252 \times 10^6 \times 1.41 \div (2{,}000 \times 1{,}000) = 1.6 \times 10^3$ tons
Normal Superphosphate	$0.484 \times 10^6 \times 0.09 \div (2{,}000 \times 1{,}000) =$ neg.
Rock Pulverization	$6.72 \times 10^6 \times 3.19 \div (2{,}000 \times 1{,}000) = 10.7 \times 10^3$ tons
Total	$12.3\ 10^3$ tons

Table G-1. Allowable Emissions, Diammonium Phosphate Based on State Regulations for States having 75 Percent of National Production Capacity

State	Annual[1] Capacity 10^3 tons	Number[1] of Plants	Allowable[2] Emissions lb/hr	Allowable Emissions, all plants lb/hr
Florida	3,520	8	22.85	182.80
Idaho	525	3	21.44	64.32
Illinois	530	3	22.38	67.14
Louisiana	1,630	4	29.85	119.40
Texas	1,240	5	35.53	177.65
TOTAL	7,445	23		611.31
US TOTAL	9,910			
%	75			

SIP Emissions: $\frac{611.31 \times 8,760}{7,445,000 \times 0.73} =$ 0.985 lb/ton DAP

Diammonium phosphate contains 70% P_2O_5 (calculated)

$$\frac{0.985}{0.70} = 1.41 \text{ lb/ton } P_2O_5$$

[1]1974 Directory of Chemical Producers, Stanford Research Institute, pp. 424-425

[2]Average of all plants calculated on a plant by plant basis, using State Regulations as published in The Environmental Reporter, using operation at 43 percent capacity. (Calculated from data in Engineering and Cost Study of Emission Control in The Phosphate Industry, Chemical Construction Corporation, December 1970, p.6.3; and Emission Standards for the Phosphate Rock Processing Industry, Chemical Construction Corporation, July 1971, Table 1.).

PHOSPHATE FERTILIZER PLANTS

List of References

1. Massoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volume II: Research Triangle Park, N.C.; Research Triangle Institute, June 1975 (Task No. 21, EPA Contract 68-02-1325).

2. Personal Communication with Ms. Gloria Cable, U.S. Department of Commerce.

3. Emission Standards for The Phosphate Rock Processing Industry, New York: Chemical Construction Corporation, July 1971.

4. Provided by EPA Project Monitor.

5. Compilation of Air Pollutant Emission Factors, AP-42, Second Edition (with changes 1-5). Research Triangle Park, N.C.: Environmental Protection Agency, December 1975.

APPENDIX H

PRIMARY SMELTERS

1970

Baseline year data (1970) are as calculated in the initial study. Estimated actual emissions for 1970 are [Ref.1, App. H]:

	10^3 Tons	
	Particulates	SO_2
Primary Copper Smelters	42	3,184
Primary Lead Smelters	1	217
Primary Zinc Smelters	2	179
Primary Aluminum Smelters	145	--
Total	190	3,580

1975 (Primary Copper, Lead, and Zinc Smelters).

Emissions data for primary smelters are summarized in Table H-1 for Copper, H-2 for Lead, and H-3 for Zinc Smelters. These data are developed on an individual smelter basis. Summary emissions for 1975 and under full compliance are:

	10^3 Tons	
	Particulates	SO_2
Copper		
1975 Potential	423	3,751
1975 Actual	31	2,661
Compliance	8	512
Lead		
1975 Potential	57	321
1975 Actual	1	240
Compliance	1	55
Zinc		
1975 Potential	69	557
1975 Actual	1	64
Compliance	1	36

Table H-1. Emissions Data, Primary Copper Smelters

NAME/LOCATION	Capacity[1] Tons/Day		1975 Compliance Status[2]		1972 Emissions[1] Tons/Day		Compliance Emissions[3] Tons/Day		1975 Estimated Emissions[4] Tons/Day		1975 Potential Emissions[5] Tons/Day	
	Conc	Metal	PM	SO_2	PM	SO_2	PM	SO_2	PM	SO_2	PM	SO_2
1. ASARCO/Tacoma, Washington	1,200	300	out	out	2.04	383.0	1.13	75.0	2.04	383.0	81	750
2. ASARCO/Hayden, Arizona	2,000	366	out	out	1.5	311.8	0.42	58.1[8]	1.5	311.8	135	1,250
3. ASARCO/El Paso, Texas	700	260	in	out	3.5	400	1.05	205	1.05	400	47.3	438
4. Phelps Dodge/Douglas, Arizona	2,260	365	out	out	48	1,394	0.61	156.5[8]	48	1,394	152.6	1,413
5. Phelps Dodge/Morenci, Arizona	2,113	470	out	out	15.5	1,294	0.60	176.9[8]	15.5	1,294	142.6	1,321
6. Phelps Dodge/Ajo, Arizona	680	197	out	out	0.7	380	0.47	61.4[8]	0.7	380	45.9	425
7. Magma/San Manuel, Arizona	1,700	310	out	out	2.33	1,080	0.58	153.6[8]	2.33	1,080	114.8	1,063
8. Kennecott/Hurley, N.M.	767	234	out	out	3.55	596	0.53	74.4[9]	355	596	51.8	479
9. Kennecott/McGill, Nevada[6]	750	185	out	out	13.0	560	0.50	121.8[10]	13.0	560	50.6	469
10. Kennecott/Hayden, Arizona	1,050	220	in	out	1.1	199	0.52	43.9[8]	0.52	199	70.9	656
11. Kennecott/Garfield, Utah	2,200	750	out	out	4.79	355	4.79[11]	72.4[12]	4.79[10]	355	148.5	1,375
12. Anaconda/Anaconda, Montana	1,710	500	out	out	22.5	790	0.58	240.0	0.58	790	115.4	1,069
13. White Pine/White Pine,Michigan	700	220	in	(7)	2.4	97	0.47	97.0[13]	0.47	97	47.3	97
14. Cities Service/Copperhill,Tenn	300	50	out	out	~0	Unk	0.27	1.3	~0	187[14]	20.3	187
15. Inspiration/Miami, Arizona	840	300	in	out	Unk	37.4	0.37	14.3[8]	0.37	37.4	56.7	374
Totals	18,970	4,727			120.91	7,877.2	24.20	1,551.6	94.4	8,064.2	1,280.7	11,366

1. Background Information for Proposed New Source Performance Standards for Primary Copper, Zinc, and Lead Smelters, Volume I. EPA-450/2-74-002a, Environmental Protection Agency, October 1974, pp. 5-3, 5-4.

2. Memorandum, Subject: Smelter Compliance Status, March 22, 1976, Grubbs to Duprey, Division of Stationary Source Enforcement, EPA, Washington, D.C.

3. Calculated using control requirements in applicable SIP's and EPA proposed or promulgated regulations. Assumption is made that EPA promulgated regulations will be sustained in any current litigations. Actual production data for each smelter is estimated by applying the ratio of reported 1975 production/ total capacity to individual plant capacities.

4. Compliance emissions used for smelters reported to be in compliance with SIP requirements and 1972 emissions for smelters reported out of compliance.

5. Massoglia, Martin F. Summary of Emission Reduction achieved nationwide by Selected Industrial Source Categories, Volume II: Appendixes. Research Triangle Park, N.C. Research Triangle Institute, June, 1975. (Task Order No. 21, EPA-Contract 68-02-1325).

6. Company announced intention of shutting down facility in June 1976. (Source, Reference 2, above).

7. No SO_2 Regulation. Emissions assumed to be uncontrolled.

8. EPA Proposed 40 FR 49365, October 22, 1975.

9. EPA Proposed, 40 FR 19213, May 2, 1975.

10. EPA promulgated. 40 FR 5512, February 6, 1975.

11. Reported actual emissions. EPA promulgated rules permit 16.1 tons particulate matter per day.

12. EPA promulgated 40 FR 54786, November 20, 1975.

13. No regulation. Compliance emissions assumed same as reported actual.

14. No data available, assumed to be uncontrolled.

Table H-2. Emission Data, Primary Lead Smelters

NAME/LOCATION	Capacity[1] Tons/Day		1975 Compliance Status[2]		1972 Emissions[1]		Compliance Emissions[3] Tons/Day		1975 Estimated Emissions[4] Tons/Day		1975 Potential Emissions[5] Tons/Day	
	Conc.	Metal	PM	SO_2	PM	SO_2	PM	SO_2	PM	SO_2	PM	SO_2
1. Bunker Hill/Kellogg, Idaho	515	350	in[6]	out	0.85	29.5	0.39	81.4[7]	0.39	29.5[9]	32.2	170.0
2. AMAX/Boss, Missouri[5]	810	380	in	out	0.25	71.0	0.49	12.0[8]	0.25[9]	71.0	50.6	267.3
3. St. Joe/Herculaneum, Missouri	745	550	in	in	0.48	200.0	0.49	12.0[8]	0.48[9]	12.0	46.6	245.9
4. ASARCO/Helena, Montana	400	105	out	in	1.56	447.8	0.33	9.9	1.56	9.9	12.4	132.0
5. ASARCO/Glover, Missouri	260	222	in	out	0.18	387.0	0.25	12.0[8]	0.18[9]	387	16.3	85.8
6. ASARCO/El Paso, Texas	220	150	in	out	0.20	217.0	0.34	38.4	0.20[9]	217	13.8	726
Totals	2,950	1,757			3.52	1,352.3	2.29	165.7	3.06	7,265	171.2	973.6

1. Background Information for Proposed New Source Performance Standards for Primary Copper, Zinc, and Lead Smelters, Volume I. EPA-450/2-74-002a, Environmental Protection Agency, October 1974, pp 5-30.
2. Memorandum, Subject: Smelter Compliance Status, March 22, 1976, Grubbs to Duprey, Division of Stationary Source Enforcement, EPA Washington, D. C.
3. Calculated using control requirements in applicable SIP's and EPA proposed or promulgated regulations. Assumption is made that EPA promulgated regulations will be sustained in any current litigations. Actual production data for each smelter is estimated by applying the ratio of reported 1975 production/ total capacity to individual plant capacities.
4. Compliance emissions used for smelters reported to be in compliance with SIP requirements and 1972 emissions for smelters reported out of compliance.

5. Massoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volume II: Appendices. Research Triangle Park, N.C., Research Triangle Institute, June, 1975. (Task Order No. 21, EPA-Control 68-02-1325).

6. DSSE Compliance data indicates smelter is in violation of fugitive emission regulations. Implies compliance with process emission regulations. Fugitive emissions not included in these data.

7. Calculated using 317,000 Scfn (from reference in note[1] above) and EPA promulgated limitations of 2,000 ppm for weak gas streams. Strong gas streams are trended at H_2SO_4 recovery plant at the collocated zinc smelter. Total compliance emissions from the combined Zn/Pb smelters do not exceed the EPA promulgated limitation of 680 tons per seven day period.

8. Missouri Regulations S-X,D specifies fenceline requirements, as such they are unenforceable. However, Regulation S-X,E limits emissions to 1,000 lb/hour. Compliance emissions are calculated on the latter.

9. Compliance emissions are greater than reported in 1972 emissions. The latter emissions are used.

Table H-3. Emission Data, Primary Zinc Smelters

NAME/LOCATION[6]	Capacity[1] Tons/Day		1975 Compliance Status[2]		1972 Emissions[1] Tons/Day		Compliance Emissions[3] Tons/Day		1975 Estimated[4] Emissions Tons/Day		1979 Potential Emissions[5] Tons/Day	
	Conc.	Metal	PM	SO_2	PM	SO_2	PM	SO_2	PM	SO_2	PM	SO_2
1. ASARCO/Corpus Christy, Texas	250	300	in	in	~0	4.9	0.44	2.6	0.44	2.6	15.0	137.5
2. ASARCO/Columbus, Ohio	200	60	in	out	~0	2.9	0.22	2.9	0.22	2.9	12.0	110.0
3. ASARCO/Amarillo, Texas[7]	270	135	out	out	4.4	162	--	--	2.2	81	8.0	68.8
4. National Zinc/Bartlesville, Oklahoma[8]	250	140	out	(15)	0.45	20.4	0.26	20.4[12]	0.45	20.4	16.0	137.5
5. Bunker Hill/Kellogg, Idaho	550	300	in[9]	out	-	14.4	0.43	15.7[13]	0.43	14.4	57.8	302.5
6. St. Joe/Monaca, Pennsylvania	875	640	in	out	1.79	53	0.12	31.4	0.12	53	91.9	481.3
7. New Jersey Zinc/Palmerton, Pa.	520	315	out	out	0.12	20	0.09	8.5	0.12	20	80.6	286.0
8. GMAX/Blackwell, Oklahoma[10]	490	275	out	out	0.25	324	--	--	0	0	--	--
9. New Facility[11]		150					0.22	28.0[14]	0	0	18.0[16]	165[16]
Totals							1.78	109.5	3.98	194.3	299.3	1,688.

1. Background Information for Proposed New Source Performance Standards for Primary Copper, Zinc, and Lead Smelters, Volume I. EPA-450/2-74-002a, Environmental Protection Agency, October 1974, pp 5-20.
2. Memorandum, Subject: Smelter Compliance Status, March 22, 1976, Grubbs to Duprey, Division of Stationary Source Enforcement, EPA, Washington, D.C.
3. Calculated using control requirements in applicable SIP's and EPA proposed as promulgated regulations. Assumption is made that EPA promulgated regulations will be sustained in any current litigations. Actual production data for each smelter is estimated by applying the ratio of reported 1975 production total capacity to individual plant capacities.
4. Compliance emissions used for smelters reported to be in compliance with SIP requirements and 1972 emissions for smelters reported out of compliance.

5. Massoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volume II: Appendices. Research Triangle Park, N.C. Research Triangle Institute, June, 1975. (Task Order No. 21, EPA-Contract 68-02-1325).

6. Does not include ASARCO/El Paso vacility. This smelter uses slag from ASARCO's primary copper smelter as raw materials. SO_2 emissions from the zinc primary process are relatively small and are not included.

7. Shut down by State order May 31, 1975. Will be replaced by electrolytic refinery in 6 months, assumed to meet emission limitations on startup. One-half of 1972 emissions used for 1975 actual and potential emission.

8. Will be shut down when replacement smelter is completed. Replacement smelter assumed to be same capacity as existing one.

9. DSSE compliance data indicates smelter is violation of fugitive emission regulations. Implies compliance with process emission regulations. Fugitive emissions not included in these data.

10. Shut down by State order. December 1973. According to EPA (EPA-450-74-002a, p.5-26) AMAX the American Zinc Company electrolytic zinc plant in St. Louis. Full capacity of 84,000 tons electrolytic zinc to be reached in 1975. No date available to permit inclusion of the St. Louis facility in this table.

11. EPA (EPA-452-74-002a, pp. 5-26, 5-27) reports that ASARCO plans to replace the capacity of the shutdown Amarillo facility with a 150 ton/day electrolytic zinc plant near Stephensport, Kentucky. Plant start-up scheduled for 1976. Emissions from this facility included in compliance emissions based on new source emission limitations.

12. No regulations. Smelter is in a priority III AQCR. 1972 actual emissions used for compliance emissions.

13. Combined with emissions from stack at associated Pb smelters, total SO_2 emissions do not exceed the EPA promulgated limitations or 680 tons/7 days.

14. Based on NSPS requirements.

15. No SIP regulations. In a priority III AQCR. Reported 1972 emissions used for compliance and 1972 actual.

16. Estimated using AP-42 emissions factors.

1975 (Primary Aluminum Smelters, Particulates only)

Estimated Actual Emission Factors

Primary aluminum production in 1975 was under two levels of control: 1970-level, and SIP-level. The SIP control level calculated in reference 1 (the initial study) has been refined to reflect SIP changes that have been made since the initial calculations. The following emission factors are applicable:

1970-level, all processes [Ref.1, p. H-4-5] 72.7 lb/tons
1975-level, all processes [Calculated below]

SIP allowable emission factors for reduction process as calculated in table H-4 is 2.9 lb/hr. This is the same as 2.9 lb/hr. calculated in the initial study [Ref.1, p. H-4-4]. Therefore the SIP emissions factor of 46.2 lb/ton previously calculated for all processes in aluminum smelting is considered to be valid [Ref.1, p. H-4-3].

Activity Factors 1975

Annual production 3.879×10^6 tons [Ref. 2]

Estimated Actual 1975 Emissions

EPA Division of Stationary Source Enforcement compliance data indicates that 56 percent of aluminum smelters as a source were in compliance with emission limitations in 1975 [Ref. 3]. Production in 1975 can be distributed over control level as follows:

1970-level $(1-0.56)(3.879 \times 10^6) = 1.707 \times 10^6$ Tons
SIP-level $(0.56)(3.879 \times 10^6) = 2.172 \times 10^6$ Tons

	1970 Control	SIP Control
Activity Factor (10^6 tons)	1.707	2.172
Emission Factor (lb/ton)	72.7	46.2
Emissions (10^3 tons)	62.0	50.2
Total	112.2×10^3 tons	

Table H-4. Synthesized Allowable Emission Factor
Primary Aluminum Smelters

State	1970[1] Capacity 000 tons	Allowable[2] Emission lb/hr	Weighted Allowable Emissions
Alabama	221	31.83	7,034
Arkansas	185	31.83	5,889
Indiana	225	43.60	9,810
Kentucky	90	43.60	3,924
Louisiana	260	43.60	11,336
Maryland	85	43.60	3,706
Montana	175	43.60	7,630
New York	253	49.38	12,493
North Carolina	100	43.60	4,360
Ohio	240	43.60	10,464
Oregon	228	43.60	9,941
Tennessee	340	43.60	14,824
Texas	561	75.74	42,490
Washington	1,016	(3)	
West Virginia	163	32.60	5,314
TOTAL	3,126		149,215

Average allowable emissions factor:

$$\frac{148,909}{3,126} = 47.64 \text{ lb/hr.}$$

On an 8.760 hours/year and a nominal production of 4,000,000 tons in 28 plants, this converts to 2.9 lb/tons of aluminum.

[1]Air Pollution Control in the Primary Aluminum Industry, Singmeister and Breyer, pp. 2-22, 2-23.

[2]From State Regulations as published in The Environmental Reporter. Based on average plant of 45 tons/hr. process rate (calculated from data in Singmeister and Breyer, pp. 2-22, 2-23) and using 2.589 tons of feed per ton of aluminum produced (Singmeister and Breyer, p. 3.2).

$$\frac{4,142,000 \text{ (total capacity)} \times 2.589}{28 \text{ (number of plants)} \times 8,760 \text{ (hrs./yr.)}} = \sim 45$$

[3]No process rate regulation. Not included in total.

1975 Potential Emissions

Activity Factor (10^6 tons)	3.879
Uncontrolled Emission Factor (lb/ton) [Ref.1, p. H-4-2]	517.7
Potential Emissions (10^3 tons)	1,004

Compliance Emissions

Activity Factor (10^6 tons)	3.879
Emission Factor (lb/ton)	46.2
Compliance Emissions(10^3 tons)	89.6

Recapitulation

Emissions, 10^3 tons

	Particulates			SO_2		
	75 Actual	75 Potential	Compliance	75 Actual	75 Potential	Compliance
Copper	31	423	8	2,661	3,751	512
Lead	1	57	1	240	321	55
Zinc	1	69	1	64	557	36
Aluminum	112	1,004	90			
Total	145	1,553	100	2,965	4,629	603

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PRIMARY SMELTERS

List of References

1. Massoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volume II: Appendices. Research Triangle Park, N.C., Research Triangle Institute, June, 1975. (Task Order No. 21, EPA-Contract 68-02-1325).
2. Personal communication with Mr. J. W. Stamper, U.S. Bureau of Mines, May 12, 1976.
3. Provided by EPA Project Monitor.

APPENDIX I

IRON AND STEEL INDUSTRY

Processes Other Than Coke Plants (Particulates Only)

1970

With the exception of emissions from Sinter Plants and Open Hearths, 1970 emissions are those calculated in the initial study [Ref. 1]. In the initial calculations, the activity factor for sintering was estimated using a ratio of sinter to pig iron based on average molecular weights. Subsequently, more valid data on sinter operations were made available by NADB. In the case of open hearth the degree of control was erroneously reported as being 95 percent. Reference to primary data source indicated the correct degree of control to be 40 percent. These data were used to refine the 1970 baseline emissions. These are summarized below.

Process	10^3 tons particulate matter*
Ore Crushing	100.0
Materials Handling	445.7
Blast Furnaces	68.6
Sinter Plants	1,272.9
Open Hearths	124.8
Basic Oxygen Furnaces	16.1
Electric Furnaces	22.2
Scarfing	7.3
Storage Piles	134.5

*Reference 1, p. I-5, except sinter plants and open hearth. (See calculations that follow).

Sinter Plants

Activity Factor	90.6×10^6 tons sinter [Ref. 2]
Emission Factor	28.1 lb/ton sinter [Ref. 1, p.I-11]
Emissions	$1,272.9 \times 10^3$ tons (Calculated)

Open Hearth

Activity Factor	48.0×10^6 tons [Ref. 3, p.53]
Uncontrolled Emission Factor	13 lb/ton steel* [Ref. 7, p.75-4]

*Assumes 50 percent use of oxygen lancing.

Overall Degree of Control	40 percent [Ref. 6, p.92]
Actual Emissions	124,800 tons

$(48.0 \times 10^6 \times 13 \times 0.40 \div 2{,}000)$

1975

Emissions from 1975 iron and steel processes were under two levels of control, 1970-level and SIP-level. While NSPS have been issued for basic oxygen furnaces and new source standards are specified in some SIP's, they are not applicable to 1975 production. NSPS for basic oxygen furnaces were promulgated on 8 March 1974. As such they are applicable only to construction started after that date. A comparison of 1970 production data for the other processes with reported 1975 data indicates no significant increase in production that would require added capacity that would be subject to new source emissions limitation.

Process Calculations

Ore Crushing:

Activity Factor 89.08×10^6 Tons

Scaled from 1970 data on the ratio of steel production 1970 to 1975

1970 Steel Production	131.1×10^6 Tons [Ref.3, p.8]
1975 Steel Production	116.783×10^6 Tons [Ref. 4]
1970 Ore Crushing	100.0×10^6 Tons [Ref.5, p.66]

$$100 \times \frac{116.783}{131.1} = 89.08 \times 10^6 \text{ Tons}$$

Emission Factors:	Uncontrolled	2 lb/tons of ore [Ref.6, p.91]
	SIP-level	2 lb/tons of ore (assumed uncontrolled)

1970 Emissions	100×10^3 Tons [Ref.1, P. I-5]
1975 Actual Emissions	$89.08 \times 10^6 \times 2 \div (2{,}000 \times 1{,}000) = 89.1 \times 10^3$ Tons
Compliance Emissions	$89.08 \times 10^6 \times 2 \div (2{,}000 \times 1{,}000) = 89.1 \times 10^3$ Tons
Potential Emissions	$89.08 \times 10^6 \times 2 + (2{,}000 \times 1{,}000) = 891 \times 10^3$ Tons

Material Handling:

Activity Factor:		116.783 x 10^6 tons Steel [Ref. 4]
Emission Factors:	1970-level	6.8 lb/ton Steel [Ref. 1, p.1-6]
	SIP-control	1 lb/ton steel [Ref. 1, p.1-7]
	Uncontrolled	10 lb/ton steel [Ref.6, p.91]

90 percent control is feasible [Ref.7, p.91] assuming that the 1975 compliance status for materials handling will be the same as average compliance of all sources. An average of 40 percent (Estimated from data provided by DSSE [Ref. 8] will be used to distribute 1975 production to levels of control as shown below

1970-level (1-0.40)(116.783) = 70.070 x 10^6 tons
SIP-level (0.46)(116.783) = 46.713 x 10^6 tons

Actual emissions for 1975 can be estimated to be

1970-level control	70.070 x 10^6 x 6.8 ÷ (2,000 x 1,000)	= 238.2 x 10^3 tons
SIP-level control	46.713 x 10^6 x 1 ÷ (2,000 x 1,000)	= 23.4 x 10^3 tons
Total		261.6 x 10^3 tons

Potential 1975 emissions

116.783 x 10^6 x 10 ÷ (2,000 x 1,000) = 5,831.9 x 10^3 tons

Compliance emissions

116.783 x 10^6 x 1 ÷ (2,000 x 1,000) = 58.4 x 10^3 tons

Blast Furnaces

Activity Factor:		79.923 x 10^6 Tons [Ref. 4]
Emission Factors:	Uncontrolled	150 lb/ton pig iron [Ref.6, p.7.5-1]
	Controlled	0.63 lb/ton pig iron [Table H-1]
	1970-level	1.5 lb/ton pig iron [Ref. 1, p. I-9]

EPA Division of Stationary Source Enforcement compliance data indicate that 64 percent of the nation's blast furnaces were in compliance with emission limitations [Ref. 9] in 1975. This permits distribution of 1975 pig iron production as follows:

1970-level (1-0.64)(79.923) = 28.77 x 10^6 tons
SIP-level (0.64) (79.923) = 51.15 x 10^6 tons

Actual 1975 emissions can be estimated to be:

1970-level	28.77 x 10^6 x 1.5 ÷ (2,000 x 1,000) =	21.6	10^3 tons
SIP-level	51.15 x 10^6 x 0.63 ÷ (2,000 x 1,000) =	16.1	10^3 tons
Total		37.7	103 tons

Table I-1. Allowable Emission Factor, Blast Furnaces, Based on Regulations of States accounting for over 70 percent of 1974 pig iron production.

State	1974 Production[1] 10^3 tons	Number of Furnaces in Blast[2]	Throughput[3] tons/per Furnace	Allowable Emission lb/ton	Total All Furnaces
Alabama	3,872	7	133.8	37.9	265.3
Illinois	7,170	13	133.4	54.2	704.6
Indiana	16,998	18	228.4	60.0	1,008.0
Michigan	7,619	9	204.8	58.8	529.2
Ohio	17,439	29	145.2	55.1	1,597.9
Pennsylvania	22,168	35	153.2	43.5	1,522.5
Total	75,266				5,627.5
U.S. Total	95,909				
%	78.5%				

Allowable Emission Factor $\frac{5,627.5 \times 24 \times 350}{75,266,000}$ = 0.63 lb/tons pig iron

[1] Iron Ore 1974, Cleveland: American Iron Ore Association, p.63.

[2] Ibid. p. 60.

[3] Based on 350 days operation, a ratio of 2.032 raw materials to pig iron (Iron Ore 1979, p.61) and State regulations as published in The Environmental Reporter.

Potential 1975 emissions:

$79.923 \times 10^6 \times 150 \div (2{,}000)(1{,}000) = 5{,}994.2 \times 10^3$ tons

Compliance emissions:

$79.932 \times 10^6 \times 0.63 \div (2{,}000)(1{,}000) = 25.2 \times 10^3$ tons

Sinter Plants

1970 Emissions are recalculated as follows:

Activity Factor: 90.6×10^6 tons [Ref.10]

Uncontrolled Emission Factor: 42 lb/ton Sinter [Ref.7, p.7.5-4]

1970 Emission Factor: 28.1 lb/ton Sinter [Ref., pI-11]

Potential Emissions: $90.6 \times 10^6 \times 42 \div (2{,}000 \times 1{,}000) = 1{,}902.6 \times 10^3$ tons

Actual Emissions: $90.6 \times 10^6 \times 28.1 \div (2{,}000 \times 1{,}000) = 1{,}272.9 \times 10^3$ tons

1975 Data:

Activity Factor: 68.708×10^6 tons sinter [Ref. 4]

Uncontrolled Emission Factor: 42 lb/ton Sinter

Complaince Emission Factors: 0.24 lb/ton Sinter [table I-2]

1970 Emission Factor: 28.1 lb/tons Sinter [Ref. 1, p.I-11]

EPA Division of Stationary Source Enforcement compliance data indicates that 22 percent of the sinter plants were in compliance with emission limitations in 1975 [Ref. 9]. This permits distribution of 1975 production to level of control as follows:

1970-level $(1-0.22)(68.708) = 55.592 \times 10^6$ Tons

SIP-level $(0.22)(68.708) = 15.116 \times 10^6$ Tons

1975 actual emissions are estimated to be:

1970-level	$55.592 \times 10^6 \times 28.1 \div (2{,}000 \times 1{,}000)$ =	781.1×10^3 Tons
SIP-level	$15.116 \times 10^6 \times 0.24 \div (2{,}000 \times 1{,}000)$ =	1.8
Total		782.9

Table I-2. Allowable Emission Factor, Sinter Plants, based on regulation for States accounting for over 70 percent of 1974 pig iron production (assuming Sinter production is proportionate to pig iron production).

State	1974 Production Pig Iron[1] 10^3 tons	Allowable Emission[2] lb/hr	Weighted Allowable lb/hr
Alabama	3,872	39.2	151,782
Illinois	7,170	47.8	342,726
Indiana	16,998	47.8	812,504
Michigan	7,619	47.8	364,188
Ohio	17,439	47.8	833,584
Pennsylvania	22,168	22.9	507,647
Total	75,266		3,012,431
U. S. Total	95,909		
%	78.5		

Allowable Emissions $\frac{3,012,431}{75,266} = 40.0$ lb/hr

$\frac{40.0 \times 24}{4,000} = 0.24$ lb/ton Sinter

[1]Iron Ore, 1974, Cleveland: American Iron Ore Association, p.63.

[2]Based on average plant size - 4,000 tons/day (A Systems Analysis of the Integrated Iron and Steel Industry, Battelle Memorial Institute, May 1969).

1975 Potential Emissions

$68.708 \times 10^6 \times 42 \div (2{,}000 \times 1{,}000) = 1{,}442.9 \times 10^3$ tons

Compliance Emissions:

$68.708 \times 10^6 \times 0.25 \div (2{,}000 \times 1{,}000) = 8.6 \times 10^3$ tons

Open Hearths

Activity Factor:	22.165×10^6 tons Steel [Ref. 4]	
Emission Factors:	Uncontrolled	13 lb/ton Steel [Ref. 7, p.7.5-4]
	Compliance	1.28 lb/ton Steel [Ref. 1, p.I-12]
	1970-level	5.6 lb/ton Steel (40 percent average control

EPA Division of Stationary Source Enforcement data indicate that 27 percent of open hearth in operation in 1975 were in compliance with emission limitations. This permits distribtuion of 1975 production by control level as follows:

1970-level: $(1-0.27)(22.165) = 16.18 \times 10^6$ tons

SIP-level: $(0.27)(22.165) = 5.98 \times 10^6$ tons

Actual 1975 emissions are estimated to be:

1970-level: $16.18 \times 10^6 \times 5.6 \div (2{,}000 \times 1{,}000) = 48.3 \times 10^3$ tons

SIP-level: $15.98 \times 10^6 \times 1.28 \div (2{,}000 \times 1{,}000) = 3.8 \times 10^3$ tons

Total: 52.1×10^3 tons

1975 Potential Emissions:

$22.165 \times 10^6 \times 13 \div (2{,}000 \times 1{,}000) = 144.1 \times 10^3$ tons

Compliance Emissions:

$22.165 \times 10^6 \times 1.28 \div (2{,}000 \times 1{,}000) = 14.2 \times 10^3$ tons

Basic Oxygen Furnaces

Activity Factor:	71.800×10^6 tons [Ref. 4]	
Emission Factors:	Uncontrolled	51 lb/ton Steel [Ref. 7, p.7.5-4]
	Compliance	0.17 lb/ton Steel [Ref. 1, p.I-14]
	1970-level	0.51 lb/ton Steel [Ref. 1, p.I-15]

EPA Division of Stationary Source Enforcement data indicate that 28 percent of basic oxygen furnaces were in compliance with emission limitations in 1975. This permits distribution of 1975 production by control level as follows:

1970-level $(1-0.28)(71.800) = 51.696 \times 10^6$ tons

SIP-level $(0.28)(71.800) = 20.104 \times 10^6$ tons

Actual 1975 emissions are estimated to be:

1970-level: $51.696 \times 10^6 \times 0.51 \div (2{,}000 \times 1{,}000) = 13.2 \times 10^3$ tons

SIP -level: $20.104 \times 10^6 \times 0.17 \div (2{,}000 \times 1{,}000) = 1.7 \times 10^3$ tons

Total: 14.9×10^3 tons

1975 Potential Emissions:

$71.800 \times 10^6 \times 51 \div (2{,}000 \times 1{,}000) = 1{,}830.9 \times 10^3$ tons

Compliance Emissions:

$71.800 \times 10^6 \times 0.17 \div (2{,}000 \times 1{,}000) = 6.1 \times 10^3$ tons

Electric Arc Furnaces

Activity Factor: 22.818×10^6 tons [Ref. 4]

Emission Factors: Uncontrolled 10 lb/ton Steel [Ref. 7, p.7.5-4]

Compliance 1.57 lb/ton Steel [Ref.1, p.7-16]

1970 2.2 lb/ton Steel [Ref.1, p. I-17]

EPA Division of Stationary Source Enforcement data indicates that 61 percent of electric arc furnaces were in compliance with emission limitations in 1975 [Ref. 9]. This permits distribution of 1975 production to control levels as shown below.

1970-level: $(1-0.61)(22.818) = 8.899 \times 10^6$ tons

SIP-level: $(0.61)(22.818) = 13.919 \times 10^6$ tons

Actual 1975 emissions are estimated to be:

1970-level: $8.899 \times 10^6 \times 2.2 \div (2{,}000 \times 1{,}000) = 9.8 \times 10^3$ tons

SIP-level: $13.919 \times 10^6 \times 1.57 \div (2{,}000 \times 1{,}000) = 10.9 \times 10^3$ tons

Total 20.7×10^3 tons

1975 Potential Emissions:

$22.818 \times 10^6 \times 10 \div (2{,}000 \times 1{,}000) = 114.1 \times 10^3$ tons

Compliance Emissions:

$22.818 \times 10^5 \times 1.57 \div (2{,}000 \times 1{,}000) = 17.9 \times 10^3$ tons

Scarfing

Activity Factor: 40.7×10^6 tons Steel

Estimated by applying ratio of 1975 to 1970 steel production to reported 1970 scarfing activity.

1970 Scarfing 45.7×10^6 tons Steel [Ref.5, p.66]

$$\frac{45.7 \times 116.783}{131.1} = 40.7$$

Emission Factors: 1970-level 0.32 lb/ton [Ref.5, p.66]
SIP-level 0.32 assumed same as 1970 level
Uncontrolled 1 lb/ton steel [Ref.7, p.7.5-4]

1975 Actual Emissions (also Compliance Emissions)
$40.7 \times 10^6 \times 0.32 \div (2{,}000 \times 1{,}000) = 6.5 \times 10^3$ tons

1975 Potential Emissions:
$40.7 \times 1 \div (2{,}000 \times 1{,}000) = 20.4 \times 10^3$ tons

Storage Pile Losses

Activity Factor: 239.6×10^6 tons

Estimated by applying ratio of 1975 to 1970 steel production to reported 1970 storage pile activity.

1970 Activity = 269.0×10^6 tons [Ref.5, p.60]

$$\frac{269 \times 116.783}{131.1} = 239.6$$

Emission Factor: 1970-level 1 lb/ton [Ref.5, p.65]
SIP-level assumed same as 1970 level
Uncontrolled 20 lb/ton materials [Ref.5, p.66]

Actual 1970 Emissions (also Compliance Emission):
$239.6 \times 10^6 \times 1 \div (2{,}000 \times 1{,}000) = 119.8 \times 10^3$ tons

1975 Potential Emissions:
$239.6 \times 10^6 \times 20 \div (2{,}000 \times 1{,}000) = 2{,}396.0 \times 10^3$ tons

Coke Plants (particulates and SO_2)

1970

Baseline year data (1970) are as calculated in the initial study. Estimated actual emissions for 1970 are [Ref.1, p.0-3]:

Particulates	153.5×10^3 tons
SO_2	180.3×10^3 tons

1975

Estimated Actual Emission Factors

Coke ovens in operation in 1975 were subject to two levels of control, 1970-level and SIP-level. Emission factors, developed in reference 1, as shown below, are considered to reflect current SIP requirements [Ref.1, p.0-4, 0-5].

	lb/ton Coke	
	1970-level	SIP-level
Particulates	3.27	0.97
SO_2	4.2	0.6

Activity Factors, 1975

The U.S. Bureau of Mines reports that 82,228,000 tons of coal were charged into Coke ovens in 1975 [Ref. 2]. Applying a ratio of coal-to-coke of 1.43 generates the following 1975 coke production data.

$$88.228 \div 1.43 = 57.502 \times 10^6 \text{ tons Coke}$$

Estimated Actual 1975 Emissions

EPA Division of Stationary Source Enforcement compliance data indicate that nine percent of the Coke oven batteries were in compliance with emission limitations in 1975 [Ref. 9]. Because the data does not distinquish between particulate and SO_2 emissions, the degree of compliance is assumed to apply to both pollutants. This indicates the following distribution of 1975 production by level of control.

1970-level $(1-0.10)(57.502) = 51.752 \times 10^6$ tons

SIP-level $(0.10)(57.502) = 5.750 \times 10^6$ tons

Actual 1975 emissions are estimated to be:

	1970-level	SIP-level
Particulates		
Activity Factor (10^6 tons)	51.752	5.750
Emission Factor (lb/ton)	3.27	0.97
Emissions (10^3 ton)	84.6	2.8

Total particulate emissions $84.6 + 2.8 = 87.4 \times 10^3$ tons

SO_2

Activity Factor (10^6 tons)	51.752	5.750
Emission Factor (lb/ton)	4.2	0.6
Emissions (10^3 tons)	108.7	1.7

Total SO_2 Emissions 108.7 + 1.7 = 110.4 x 10^3 tons

1975 Potential Emissions

Uncontrolled Emission Factors

Particulates	3.5 lb/ton coal charged [Ref.1, p.0-4]
SO_2	4.2 lb/ton coal charged [Ref.1, p.0-4]

Particulate Emissions 82,228,000 x 3.5 ÷ (2,000 x 1,000) = 143.9 x 10^3 tons

SO_2 82,228,000 x 4.2 ÷ (2,000 x 1,000) = 172.7 x 10^3 tons

Compliance Emissions

Controlled Emission Factors

Particulates	0.97 lb/ton of Coal [Ref. 1]
SO_2	0.6 lb/ton of Coal [Ref. 1]

Particulates 82,228.000 x 0.97 ÷ (2,000 x 1,000) = 39.9 x 10^3 tons

SO_2 82,228.000 x 0.6 ÷ (2,000 x 1,000) - 24.7 x 10^3 tons

Recapitulation

Particulate Emissions 10^3 Tons

Process	1970 Actual	1975 Potential	1975 Actual	Compliance
Ore Crushing	100.0	89.1	89.1	89.1
Materials Handling	445.7	583.9	261.6	58.4
Blast Furnaces	68.6	5,994.2	33.7	25.2
Sinter Plants	1,272.9	1,442.9	782.9	8.6
Open Hearth	124.8	144.1	52.1	14.2
Basic Oxygen Furnace	16.1	1,830.9	14.9	6.1
Electric Arc Furnaces	22.2	114.1	20.7	17.9
Scarfing	7.3	20.4	6.5	6.5
Storage Piles	134.5	2,396.0	119.8	119.8
Coke Ovens	153.5	143.9	87.4	39.9
	2,345.6	12,759.5	1,468.7	385.7

List of References

1. Massoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volume II: Research Triangle Park, N.C.; Research Triangle Institute, June 1975 (Task No. 21, EPA Contract 68-02-1325).

2. Provided by C. Mann, NADB, EPA/Durham.

3. Annual Statistical Report, 1973, American Iron and Steel Institute.

4. Personal communication with Ms. Betty Thompson, American Iron and Steel Institute, May 24, 1976.

5. OAQPS Data File of Nationwide Emissions. Research Triangle Park, N.C.; Environmental Protection Agency, April 1973.

6. Particulate Pollutant Emission Study, Volume I, Mass Emissions, Kansas City: Midwest Research Institute, May 1971.

7. Compilation of Air Pollutant Emissions Factors, AP 42, Second Edition (with changes 1-5). Research Triangle Park, N.C.: Environmental Protection Agency, December 1975.

8. A Systems Analysis Study of the Integrated Iron and Steel Industry. Columbus: Battelle Memorial Institute, May 1969.

9. Provided by EPA Project Monitor.

10. Minerals Yearbook, 1970 as cited in OAQPS data file (Ref.5 above).

11. Personal Communications with Mr. L. W. Westerstrom, U.S. Bureau of Mines, May 14, 1976.

APPENDIX J

FERROALLOY PLANTS
(Particulate Matter Only)

1970

In the initial study [Ref. 1], the reported 1967 degree of control was assumed to be applicable in 1970. The data developed by NADB [Ref. 2] are considered to be based on more current data than that used in the initial study. Consequently, 1970 estimated actual emissions used in subsequent analysis will be 71×10^3 tons of particulates.

1975

Emissions from 1975 Ferroalloy processes were under two levels of control, the 1970-level and the SIP-level. The synthesized SIP emission factor used in the initial study has been refined to reflect changes in SIP's since 1974 and more current production data [See table J-1]. Estimated actual emission factors for 1970 have been recalculated using the more current data mentioned above. The following emission factors are used in subsequent analyses.

1970-level	80.2 lbs/ton Ferroalloy
[71,000 x 2,000 (total emissions) ÷	1,770,000 (production, ref.2)]
SIP-level	4.74 lb/ton Ferroalloy

1975

Activity Factors

Ferroalloy Production 1.786×10^6 tons

Latest production data available are for 1974. The Bureau of Mines reports 1974 Ferroalloy production as 2.266×10^6 tons [Ref. 3]. The U.S. Ferroalloy Association reports a decline of 22 percent in 1975 production [Ref. 4].

$$2.266 \times (1-0.22) = 1.786 \times 10^6 \text{ tons}$$

Estimated Actual 1975 Emissions

EPA Division of Stationary Sources Enforcement compliance data indicate that 55 percent of the ferroalloy plants were in compliance with emission limitations in 1975 [Ref. 5]. This indicates the following

Table J -1. Allowable Emission Factor, Ferroalloy Industry Process

States	Number of Furnaces	Existing Plants		New Plants	
		Allowable[2] lb/hr	Emissions All Furnaces lb/hr	Allowable[3] lb/hr	Emissions All Furnaces lb/hr
Ohio	57	25.78	1,469.46	25.78	1,469.46
Alabama	12	19.68[3]	236.16	19.68	236.16
Tennessee	14	25.78	360.92	19.68	275.52
West Virginia	25	22.66	566.50	22.66	566.50
Kentucky	15	25.78	386.70	25.78	386.70
TOTAL	123		3,019.74		2,934.34
US TOTAL	158				
%	77.8				

Allowable emissions[4]

Existing plants $\frac{3,019.74}{123 \times (15.55 \div 3)} =$ 4.74 lb/ton of product

New Plants $\frac{2,934.34}{123 \times (15.55 \div 3)} =$ 4.60 lb/ton

[1]Engineering and Cost Study of the Ferroalloy Industry, EPA-450/2-74-008, Environmental Protection Agency, May 1974 p.E-3

[2]Based on an average charge rate of 15.55 tons/hr (ref.1, above, p.VI-39), and state regulations as published in the Environmental Reporter.

[3]Based on Class 1 county allowable emission rules.

[4]Ratio of charge to product is 3:1 (calculated from data ref. 1, above, p. VI-39)

distribution of 1975 production by level of control.

1970-level	$1.786 \times (1-0.55)$	=	0.804×10^6 tons
SIP-level	1.786×0.55	=	0.982×10^6 tons

Actual 1975 emissions are estimated to be:

	1970-level	SIP-level
Activity Factor (10^6 tons)	0.804	0.982
Emissions Factor (lb/ton)	80.2	4.74
Emissions (10^3 tons)	32	2

Total particulate emission 34×10^3 tons

1975 Potential Emissions

1971 Uncontrolled emissions 377,000 Tons [Ref. 6, p.vi-19]

1971 Production 2.151×10^6 Tons [Ref. 6, p.vi-19]

Emission Factor $377{,}000 \div (2.151 \times 10^6) = 0.175$ lb/ton

1975 Production 1.786×10^3 tons

1975 Potential emissions $(1.786)(0.175) \div 1{,}000 = 313 \times 10^3$ tons

Compliance Emissions

From Process

1975 Production 1.786×10^3 tons

Compliance Emission Factor 4.74 lb/ton

Compliance Emissions $(1.786 \times 10^3)(4.74) \div (2{,}000 \times 1{,}000) = 4.2 \times 10^3$ tons

From Raw Materials Handling (Charge to product ratio 3:1)

Emission Factor 0.29% [Ref.6, p.vi-29]

$3 \times 1.786 \times 10^3 \times 0.0029 \div 1{,}000 = 15.5 \times 10^3$ tons

From Product Handling

Emission Factor 0.51% [Ref. 6, p.vi-31]

$1.786 \times 10^3 \times 0.0051 \div 1{,}000 = 9.1 \times 10^3$ tons

Total Compliance Emissions $4.2 + 15.5 + 9.1 = 29 \times 10^3$ tons

References

Ferroalloy Plants

1. Massoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volume II: Research Triangle Park, N.C.; Research Triangle Institute, June 1975 (Task No. 21, EPA Contract 68-02-1325).

2. Provided by C. Mann, EPA/Durham.

3. Personal communication, Mr. T. Jones, U.S. Bureau of Mines, May 12, 1976.

4. Personal communication, U.S. Ferroalloy Association, May 12, 1976.

5. Provided by EPA Project Monitor.

6. Engineering and Cost Study of the Ferroalloy Industry, EPA-450/2-74-008, Research Triangle Park, N.C.: Environmental Protection Agency, May 1972.

APPENDIX K

ASPHALT CONCRETE PLANTS

(Particulates only)

1970

Baseline year data (1970) are as previously calculated in the initial study. Estimated actual emissions for 1970 are 526 x 10^3 tons [Ref.1, p.K-3].

1975

Estimated Actual Emission Factors

Asphalt concrete plants in 1945 were under three levels of control: 1970-level, SIP-level, and NSPS for plants becoming operational in 1975. The following emission factors are applicable.

	lb/ton Product
1970-level [Ref.1, p.K-7]	3.38
SIP-level [Ref.1, p.K-7]	0.765
NSPS [Ref.1, p. I-4]	0.18

Activity Factors

1974 [Ref. 2]	352 x 10^6 Tons
1975 [Ref. 3]	315 x 10^6 Tons

Because 1975 production was less than 1974 it can be assumed that no capacity is subject to NSPS.

Estimated Actual 1975 Emissions

EPA Division of Stationary Source Enforcement compliance data indicates that 80 percent of the asphalt concrete plants were in compliance with particulate emission limitations in 1975 [Ref. 4]. Following is distribution of 1975 production by level of control:

1970-level	[1-0.080][315]	=	63 x 10^6 Tons
SIP-level	[0.80][315]	=	252 x 10^6 Tons

Actual 1975 emissions are estimated to be:

	1970-level	SIP-level
Activity Factory (10^6 tons)	63	252
Emission Factor (lb/ton)	3.38	0.765
Emissions (10^3 tons)	106.5	96.4

Total Emissions: 106.5 + 96.4 = 202.9 x 10^3 tons

1975 Potential Emissions

Activity Factor (10^6 tons)	315
Emission Factor (lb/ton) [Ref.5, p.8.1-4]	45
Emissions (10^3 tons)	7,088

Compliance Emissions

Activity Factor (10^6 tons)	315
Emission Factor (lb/ton)	0.765
Emissions (10^3 tons)	120

ASPHALT CONCRETE PLANTS

List of References

1. Massoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volume II: Research Triangle Park, N.C.; Research Triangle Institute, June 1975 (Task No. 21, EPA Contract 68-02-1325).

2. Personal Communication, Mr. G. Goggin, National Asphalt Paving Association, May 28, 1976.

3. Ibid, May 17, 1976.

4. Provided by EPA Project, Monitor.

5. Compilation of Air Pollutant Emission Factors, AP-42, Second Edition (with changes 1-5). Research Triangle Park, N.C.: Environmental Protection Agency, December 1975.

APPENDIX L

COAL CLEANING PLANTS

(Particulates Only)

1970

Baseline year data (1970) are as calculated in the initial study. Estimated actual emissions for 1970 are 217 x 10^3 tons [Ref.1, p.L-3].

1975

Estimated Actual Emission Factors

Emissions from 1975 operations were under three levels of control. Plants coming onstream in 1975 were subject to NSPS control and are assumed to be in compliance therewith. Some of the remaining plants in place were under the 1970 control level, the remainder in compliance with SIP requirements. The SIP control requirements calculated in the initial study [Ref. 1] have been refined to reflect SIP changes since 1974 and more current production data. The following factors will be used.

	lb/ton	
	Thermal Drying	Pneumatic Drying
1970 [Ref.1. p.L-6]	6.0	2.61
NSPS [Calculated from Ref.2]	0.11	*
SIP-control [table L-1]	0.25	0.25

*Pre-1975 capacity adequate for 1975 requirements.

Activity Factors 1975

Latest production data available are for 1974. Bureau of Mines reports 1974 production being [Ref. 3]:

Thermal Drying	36.1 x 10^6 tons
Pneumatic Drying	7.5 x 10^6 tons

The increasing demands of coal resulting from the energy crisis indicates that the 1974 level of activity could prevail for 1975 [Ref. 4].

Table L-1. Allowable Particulate Emissions, Coal Cleaning, Thermal and Pneumatic Drying (States accounting for over 90 percent of 1972 production)

State	1972[1] Production 000 tons	Allowable[2] Emission lb/hr	Number of Plants	Total Statewide lb/hr
Illinois	7,163	54.9	24	1,317.6
Kentucky	4,233	54.9	20	1,098.0
Pennsylvania	5,569	8.2	21	172.2
Virginia	4,496	54.9	20	1,098.0
West Virginia	27,600	26.1	76	1,983.6
TOTAL	49,061		161	5,669.4
US TOTAL	53,235			
%	92			

Allowable Emissions:

$$\frac{5,669.4}{161 \times 143} = 0.25 \text{ lb/ton}$$

[1] 1972 Minerals Yearbook, p. 42.

[2] Based on average plant 143 tons/hr (NESS, 1970) and State regulations as published in The Environmental Reporter.

Estimated Actual 1975 Emissions

EPA Division of Stationary Source Enforcement compliance data indicates that 74 percent of the coal cleaning plants were in compliance with emission limitations in 1975 [Ref. 5]. These compliance data, not broken down by process type, are assumed to be applicable to both thermal and pneumatic drying. Using these compliance data, the following distribution of production by control level can be estimated. In view of the decreasing production, experienced in 1975, no plants are considered to be under NSPS.

Thermal Drying			
1970-level	(1-0.74)(36.1)	=	9.39×10^6 tons
SIP-level	(0.74)(36.1)	=	26.71×10^6 tons
Pneumatic Drying			
1970-level	(1-0.74)(7.5)	=	1.95×10^6 tons
SIP-level	(0.74)(7.5)	=	5.55×10^6 tons

Actual 1975 emissions are estimated to be:

	1970-level	1975-level
Thermal Drying		
Activity Factor (10^6 tons)	9.39	26.71
Emission Factor (lb/ton)	6.0	0.25
Emissions (10^3 tons)	28.2	3.3
Total Emissions	32×10^3 tons	
Pneumatic Drying		
Activity Factor (10^6 tons)	1.95	5.55
Emission Factor (lb/ton)	2.61	0.25
Emissions (10^3 tons)	2.5	0.7
Total Emissions	3×10^3 tons	

1975 Potential Emissions

Particulates

Activity Factors: Thermal Drying 36.1×10^6 Tons
Pneumatic Drying 7.5×10^6 Tons

Uncontrolled Emission Factors: Thermal Drying 20.0 lb/ton [Ref.6,p.8.9-1]
Pneumatic Drying 3.0 lb/ton [Ref.6,p.8.9-1]

Emissions: Thermal Drying $36.1 \times 10^6 \times 20 \div (2{,}000 \times 1{,}000) = 361.0 \times 10^3$ tons
Pneumatic Drying $7.5 \times 10^6 \times 3 \div (2{,}000 \times 1{,}000) = 11.2 \times 10^3$ tons

Compliance Emissions

Particulates

Emission Factors, Thermal and Pneumatic Drying 0.25 lb/ton
Emissions $[36.1 + 7.5] \times 10^6 \times 0.25 \div 1{,}000 = 11 \times 10^3$ tons

COAL CLEANING PLANTS

List of References

1. Massoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volume II: Research Triangle Park, N.C.; Research Triangle Institute, June 1975 (Task No. 21, EPA Contract 68-02-1325).
2. Federal Register, October 24, 1974.
3. Personal communication with Mr. L. W. Westerstron, U.S. Bureau of Mines, 12 May 1976.
4. Personal communication with Mr. L. W. Westerstron, U.S. Bureau of Mines, December 16, 1974.
5. Provided by EPA Project Monitor.
6. Compilation of Air Pollutant Emission Factors, AP-42, Second Edition (with changes 1-5), Research Triangle Park, N.C.: Environmental Protection Agency, December 1975.

APPENDIX M

KRAFT AND SULFITE PULP

(Particulate Matter Only)

1970

Baseline year date (1970) are as calculated in the initial study [Ref. 1]. Estimated actual 1970 particulate emissions from Kraft and Sulfite Pulp Mills are 288 x 10^3 tons [Ref. 1, p.M-5].

1975

Estimated Actual Emission Factors

Kraft and sulfite mill operations in 1975 were under two levels of control, that existing in 1970 and that required by the SIP's. The emission factors developed in the initial study are considered to reflect the most current and valid data. These are listed below.

	lb/ton ADP	
	1970 Control*	SIP Control**
Recovery Boilers	17.64	1.96
Lime Kiln	4.50	0.41
Total	22.14	2.41

*Reference 1, p. M-5.

**Calculated from data in Reference 2, p.4 and uncontrolled emission factors published in AP-42 [Ref. 3, p.10.1-5].

Activity Factors

The American Paper Institute reports that 31.32 x 10^6 tons of ADP were processed in 1975 [Ref. 4].

Estimated Actual Emissions

EPA Division of Stationary Source Envorcement compliance data indicates that 65 percent of the Kraft and Sulfite Pulp emission sources were in compliance with emission limitations in 1975. No breakdown by process is

available. Therefore this compliance data will be assumed to be the same for all processes. The following distribution of 1975 activity by level of control can be calculated.

1970-level	$31.32 \times 10^6 \times (1-0.65)$		10.96×10^6 tons
SIP-level	$31.32 \times 10^6 \times 0.65$	=	20.36×10^6 tons

Actual 1975 emissions are estimated to be:

	1970-level	SIP-level
Activity Factor (10^6 tons ADP)	10.96	20.36
Emission Factor (lb/ton ADP)	22.14	2.41
Emissions (10^3 tons)	121.3	24.5

Total emissions 121.3 + 24.5 = 146×10^3 tons

1975 Potential Emissions

Activity Factor	31.32×10^6 tons
Uncontrolled Emission Factor	242 lb/ton [Ref.5, p.10.1-J]
Potential Emissions	$3,789 \times 10^3$ tons

Compliance Emissions

Activity Factor	31.32×10^6 tons
Compliance Emission Factor	2.41
Compliance Emissions	38×10^3 tons

KRAFT AND SULFITE PULP

List of References

1. Massoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volume II: Research Triangle Park, N.C.; Research Triangle Institute, June 1975 (Task No. 21, EPA Contract 68-02-1325).

2. Particulate Pollution Control Equipments for the Pulp and Paper Industry. EPA furnished document, undated (Probable origin is Department of Commerce, 1974).

3. Compilation of Air Pollutant Emission Factors. AP-42, Second Edition with changes 1-5, Research Triangle Park, Environmental Protection Agency, December 1975.

4. Personal communication with a staff associate at American Paper Institute, May 14, 1976.

5. Compilation of Air Pollutant Emission Factors, AP-42, Second Edition (with changes 1-5). Research Triangle Park, N.C.: Environmental Protection Agency, December 1975.

APPENDIX N

GREY IRON FOUNDRIES

(Particulate Matter Only)

1970

Baseline year data (1970) are as calculated in the initial study [Ref. 1]. The estimated actual 1970 emissions are based on a production of 17,923 x 10^3 tons [Ref.2, p.51]. This figure is compatible with the shipment of 13,946 x 10^3 tons of grey iron castings in 1970 as reported by The Department of Commerce. [Ref.3, p.154]. The OAQPS 1970 data File [Ref.4, p.71] lists 1970 production as 24,000 x 10^3 tons. However, the figure of 17,923 x 10^3 tons is considered more current and will be used. Consequently, 1970 baseline particulate emissions of 156 x 10^3 tons of particulates as calculated in reference 1, will be used in subsequent analyses.

1975

Estimated Actual Emission Factors

Grey iron foundry capacity in 1975 was under two levels of control, 1970-level and SIP-level. The following emission factors calculated in the initial study are considered to reflect current data and will be used.

1970 Factor	17.37 lb/ton
SIP Factor	7.41 lb/ton

Activity Factors, 1975

The U.S. Bureau of Mines reports 1975 production of grey iron to be 12.4 x 10^6 tons [Ref.4]

Estimated Actual 1975 Emissions

EPA Division of Stationary Source Enforcement compliance data indicate that 74 percent of the grey iron foundries were in compliance with emission limitations in 1975. This generates the following distribution of 1975 activity by control level.

1970-level	$(12.4 \times 10^6)(1-0.74)$	=	3.2×10^6 tons
SIP-level	$(12.4 \times 10^6)(0.74)$	=	9.2×10^6 tons

Actual 1975 emissions are estimated to be:

	1970-Control	SIP-Control
Activity Factor (10^6 tons)	3.2	9.2
Emission Factor (lb/ton)	17.37	7.41
Emissions (10^3 tons)	27.7	34.1
Total Emissions	27.7 + 34.1 = 62 x 10^3 tons	

1975 Potential Emissions

Activity Factor	12.4 x 10^6 tons
Uncontrolled Emission Factor	145 lb/ton [Ref.1, p.N-4]
Compliance Emissions	899 x 10^3 tons

Compliance Emissions

Activity Factor	12.4 x 10^6 tons
Compliance Emission Factor	7.41 lb/ton
Compliance Emissions	46 x 10^3 tons

GREY IRON FOUNDRIES

List of References

1. Massoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volume II: Research Triangle Park, N.C.; Research Triangle Institute, June 1975 (Task No. 21, EPA Contract 68-02-1325).

2. Background information for Establishment of National Standards of Performance for New Source (Draft) Cincinnati: PEDCO Environmental Specialists, Inc., March 1971.

3. 1971 Business Statistics, Washington, D.C., Office of Business Economics, U.S. Department of Commerce, October 1971.

4. Personal communication with Mr. H. Reno, U.S. Bureau of Mines, May 12, 1970.